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OFFSHORE PLATFORM HAZARDOUS WASTE INCINERATION FACILITY: FEASIBILITY STUDY

by

R. J. Corey, G. G. Engleman, F. E. Flynn, R. J. Johnson, E. L. Moon,
T. L. Sarro, R. L. Tan, S. L. Unger, P. J. Weller, and C. A. Zee

TRW Environmental Engineering Division
Redondo Beach, California 90278

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16. ABSTRACT

The report describes a feasibility study of using an existing offshore oil platform, being offered to the Government, as a site for incineration of hazardous wastes and related research. The platform, located in the Gulf of Mexico about 100 km south of Mobile, AL, has potential as an environmentally safe site for operational and research oriented incineration. The study indicates that an incinerator, capable of destroying a wide range of waste types at up to 3 metric tons/hour, can be installed on the platform along with the necessary support facilities. An environmental assessment of worst-case air and water quality impacts from waste incineration revealed insignificant air quality effects at the nearest land point and on the platform. Water quality effects will not be significant for most wastes. For highly toxic and persistent substances, an activated carbon scrubber water treatment system can be provided. Estimated capital costs were $6.6 million for offshore and shore base facilities, and waste transportation containers. Labor, offshore personnel subsistence, fuel, transportation, maintenance, depreciation, and land lease costs were estimated at $3.9 million/year, or approximately $298/metric ton of waste incinerated for 12 hour/day, 7 day/week operation. Continuous and intermittent operation of the incinerator were also considered.

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a. DESCRIPTORS		b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
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Offshore Structures	Scrubbers	Stationary Sources	13M 07A,13I
Incinerators		At-Sea Incineration	
Waste Disposal		Hazardous Wastes	
Toxicity			06T
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ABSTRACT

This report describes a study conducted to determine the feasibility of using an existing offshore oil platform as a site for destruction of hazardous wastes and incineration research. Chevron U.S.A., Inc. has offered to transfer this platform, Main Pass Block 254 "A" Structure, to the Federal Government at no cost. The platform is located in the Gulf of Mexico, approximately 100 km. south of Mobile, Alabama. Results of the study indicate that a rotary kiln incinerator with a high temperature afterburner, capable of destroying a wide range of waste types at up to 3 metric tons/hour, can be installed on the platform along with the necessary support facilities, including personnel quarters, utilities, waste handling and storage, etc. An environmental assessment of worst case air and water quality impacts from waste incineration revealed insignificant air quality effects at the nearest land point and on the platform. Water quality effects should be correlated with a marine environmental assessment performed by TerEco Corp. Estimated capital costs were $5.8 million for offshore and shore base facilities, and waste transportation containers. Labor, offshore personnel subsistence, fuel, transportation, maintenance, depreciation, and land lease costs were estimated at $3.8 million/year, or approximately $287/metric ton of waste incinerated for 12 hour/day, 7 days/week operation. Continuous operation of the incinerator would reduce operating costs to approximately $220/metric ton. Cost of liability insurance, if risk is not assumed by the Federal Government, may be as high as $3 to $6 million/year.

This report is submitted in fulfillment of Contract No. 68-02-2613, Task No. 29, by TRW Inc., Environmental Engineering Division, under the sponsorship of the U. S. Enivironmental Protection Agency. This report covers work performed during the period from April 3, 1979, to November 30, 1979.

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Drawings and detailed information for the Main Pass Block 254 "A" Structure were furnished by Chevron U.S.A. Inc. The U.S. Coast Guard provided spill data from their computer storage system and contributed to project review meetings. The U. S. Environmental Protection Agency's Oil and Special Materials Control Division also participated in project reviews and supplied information. Technical direction and assistance was received from the EPA Industrial Environmental Research Laboratory, Research Triangle Park, North Carolina.

The authors are indebted to the many individuals of all of these organizations for their contributions.

1. INTRODUCTION

Chevron U.S.A. Inc. has offered to transfer an offshore oil platform, Main Pass Block 254 "A" Structure, to the Federal Government. This platform, constructed in 1975 at a cost of $11,587,000, is located in the Gulf of Mexico approximately 100 kilometers (60 miles) south of Mobile Point, Alabama, and 120 kilometers (75 miles) east of North Pass, Louisiana. The U. S. Environmental Protection Agency (EPA) and the U. S. Coast Guard (USCG) have made a preliminary determination that the platform has potential as a site for installing a high temperature incinerator for use in the disposal of hazardous material, including wastes resulting from cleanup operations, and for conducting research on thermal destruction of waste.

The preliminary evaluation took into account the necessity to destroy highly toxic waste at a location with minimum risk to public health and the environment, the need for further research on destruction of hazardous waste, and the cost advantages of at-sea incineration of toxic materials. A joint EPA/USCG task force has been established to undertake a comprehensive analysis of this concept. The study will focus on the environmental, technical, and administrative aspects of accepting this offshore platform for use as a hazardous waste incineration facility. Structural integrity of the platform will be determined by the USCG.

This report describes a program conducted to evaluate the technical and environmental feasibility of using the proposed offshore platform incineration facility in the destruction of hazardous wastes and for incineration research. Specific objectives of the study were:

- Review the literature to identify related EPA/USCG projects and list hazardous waste research and operational disposal needs.
- Evaluate existing hazardous material incineration systems.
- Design a conceptual incinerator system based upon existing commercially available hazardous waste incineration systems or components.
- Prepare a monitoring plan, systems operation plan, and cost analysis for the conceptual incineration system.
- Develop requirements, conceptual design, and cost estimates for offshore and shore base support facilities, and for a multimodal container for transporting hazardous material.

- Estimate the environmental effects on air and water quality from incineration of hazardous materials at the proposed offshore platform site.

A subcontract was issued to TerEco Corporation during the latter part of this program to provide a marine environmental assessment for the offshore site. This assessment is provided in a separate report submitted by TerEco directly to EPA.

Results of the offshore incineration platform feasibility study conceptual design are summarized in the following report section. Subsequent sections describe the literature review and incineration systems evaluation, conceptual design of the incinerator and support facilities, and the environmental assessment. Details of the facility design and costs are included in the appendices to this report.

2. SUMMARY

Results of this study have demonstrated the basic technical and environmental feasibility of the proposed offshore platform for use as a hazardous waste incineration site. In addition, investigations undertaken as part of this study indicated the critical national need for an environmentally safe location for operational destruction of highly toxic substances and incineration research. Bases for these conclusions are:

- Review of the literature revealed requirements for waste combustion research and incineration of hazardous materials that are environmentally or economically infeasible at land-based facilities (Section 3).
- Evaluation of both commercial and EPA developed incineration systems indicate that a rotary kiln coupled to a high temperature liquid injection afterburner is the most versatile system for thermal destruction of a wide variety of waste types (Section 4).
- A conceptually designed rotary kiln/afterburner incineration system, based upon commercially available, performance-proven components can be installed and operated on the proposed ocean platform. Maximum design feed rates are 3.0 metric tons/hour of liquids and pumpable slurries, or 1.5 metric tons/hour of solid material (Section 5).
- Although the platform deck area is limited, conceptual design of the offshore support facility has shown that all required subsystems, including life support systems and container handling, can be accommodated (See Figure 1). A shore base facility was designed to meet all requirements for waste handling and storage. Standard commercially available containers were identified for transporting liquid and dry waste materials (Section 6).
- Estimated environmental effects on air and water quality from incineration of typical hazardous wastes (Section 7) indicated insignificant air quality impact at the nearest land point. Air quality degradation on the platform itself is considered unlikely because of structural and meteorological conditions. Water quality effects from quench/scrubber effluents should be reviewed in conjunction with a marine environmental assessment performed by TerEco Corporation.

Cost estimates for the conceptual incineration system and support facilities are summarized in Table 1. Details can be found in Section 5.4.1 for the incineration system and in Section 6.5 for support facilities. Current list prices of commercially available equipment and

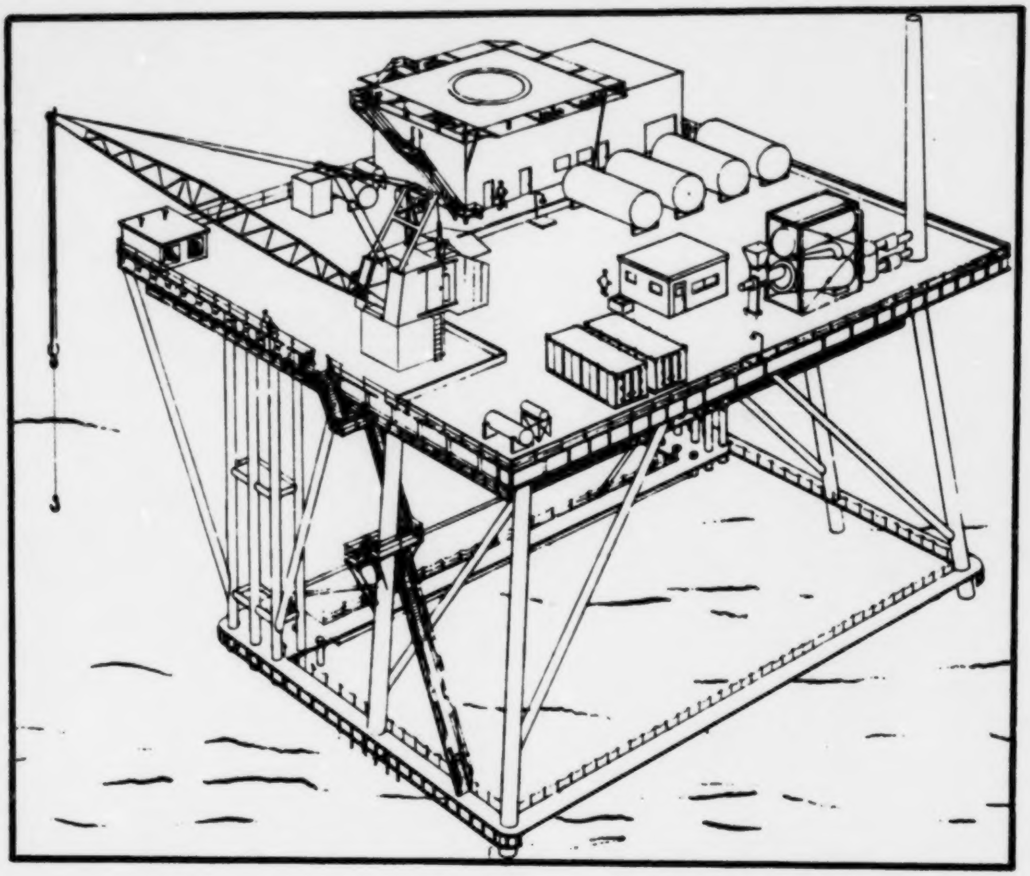

Figure 1. Proposed Offshore Incineration Platform

components were used whenever applicable. Installation costs of systems can only be considered as rough estimates because of uncertainties in labor costs and potential delays inherent in offshore operations. All costs are given in October 1979 dollars and must be adjusted for future procurement and construction time periods.

TABLE 1. SUMMARY OF ESTIMATED COST - INCINERATION SYSTEM AND FACILITIES

Incineration System	$2,479,000
Offshore Support Facility	2,095,900
Shore Based Facility	647,700
Multimodal Waste Containers	276,200
Miscellaneous Equipment	43,400
Transportation and Miscellaneous Equipment	257,800
TOTAL	$5,800,000

Yearly operating costs for the offshore platform and onshore facilities are listed in Table 2. These costs do not include cost of insurance. The bases for these estimates are given in Sections 5.4.2 and 6.5.5.

TABLE 2. YEARLY OPERATING COST ESTIMATE - OFFSHORE AND SHORE BASED FACILITIES

Offshore Platform			
Labor	12 persons, 12 hrs/day, 7 days/week	$ 960,000	
Subsistence	12 persons, 365 days	53,000	
Fuel	890,000 gallons of diesel oil	801,000	
Transportation	waste, fuel, supplies,	156,000	
	helicopter service	52,000	
Maintenance	12% of equipment costs	429,100	
Depreciation	20% of equipment costs	715,100	
	10% of building costs	72,700	
	Total		$3,238,900
Shore Based Facility			
Labor	8 persons, 260 days	$ 297,000	
Maintenance	8% of equipment costs	20,000	
Depreciation	20% of equipment costs	50,100	
	5% of building costs	6,300	
Land Lease	including dock use	57,600	
	Total		$ 431,000
Total Yearly Operating Costs (without insurance costs)			$3,769,900

Insurance cost is not included in this estimate for two reasons: 1) if the federal government assumes liability, no insurance cost is involved; 2) if a contractor must obtain insurance, the cost will vary greatly depending upon many factors not defined at this time and may exceed all other operational costs combined. Liability insurance coverage may cost $3 to $6 million/year, as discussed in Section 5.4.2.

At the maximum waste feed rate of 3 metric tons/hour for 12 hours/day, 7 days/week, the total offshore platform and land based facility operating costs average $287/metric ton, without insurance cost. Operational costs would increase by approximately $2 million for 24 hour/day incineration because of additional labor, subsistence, fuel, and transportation costs. However, with other costs remaining essentially the same, operating costs per metric ton of waste incinerated would decrease to approximately $220, without insurance costs, for continuous operation of the incinerator.

Cost of diesel oil for auxiliary fuel may be reduced by use of high heat content wastes for incineration of wastes which do not sustain high temperature combustion. Utilization of gas or oil provided by tapping reserves at the platform site was considered, but use of diesel fuel was assumed because existing wells are plugged and also contain H_2S. Diesel oil will also be used for power generation and decontamination of waste containers (then burned as auxiliary fuel in the incinerator).

The conceptual designs of the incineration system and support facilities prepared for this study evidence the technical feasibility of the proposed offshore incineration platform, and serve as a basis for initial cost estimates. Results of the environmental assessment indicated only minor air and water impacts from incineration of topical hazardous wastes. However, for extremely toxic wastes, such as dioxins, a more rigorous analysis should be made. This would require more detailed meteorological and marine data for the specific site than is presently available.

3. LITERATURE REVIEW

A review of the literature was conducted to identify EPA and U.S. Coast Guard projects related to hazardous waste incineration, and to list research and operational needs which might be met by utilizing an offshore incineration platform.

3.1 PAST AND CURRENT EPA RESEARCH PROJECTS

Prior to determining both the conceptual design of the hazardous waste incinerator to be used on the offshore platform and the technical direction of the offshore incineration program, a literature search was conducted in the area of hazardous waste incineration. A computer search through the NTIS files under the root words "hazard . .," "waste . .," and "incinerate . ." revealed 62 entries for the titles containing the above root words and 24 entries for those titles published by the Environmental Protection Agency. Table 3 presents some of the research sponsored by the Environmental Protection Agency since 1974. Much of the research reported has centered on the evaluation of existing incineration equipment for the destruction of hazardous wastes.

Early research focused on firing municipal refuse in existing boilers. Usually the boilers were co-fired with coal due to the low heating value of refuse. Although municipal refuse is not necessarily a hazardous waste, by studying refuse incineration much technical data concerning thermal destruction as a means of disposing of solid organic wastes can be gathered which is applicable to the incineration of hazardous wastes. Off-gases from refuse incineration were monitored for total particulates, particulate size distribution, and various toxic gaseous compounds (EPA-650/2-74-0-73). The effect of chloride and sulfur on corrosion of boiler tubes was studied (EPA Research Grant No. R800055). Increased amounts of sulfur resulted in reduced corrosion rates. Finally, the environmental impact of using refuse in a boiler was assessed (EPA-650/2-75/044 and EPA Research Grant No. R804008-2).

TABLE 3. SUMMARY OF EPA INCINERATION PROJECTS

Report #	Author	Title	Date	Objectives	Accomplishments
EPA-650/2-74-0-73	Shannon, L.J., et. al. Midwest Research Institute	"St. Louis/Union Electric Refuse Firing Demonstration Air Pollution Test Report"	August 1974	To determine effects of mixed-fuel firing on boiler emissions and ESP performance at the St. Louis/Union Electric Meramec facility. Fuel is RDF	Tests were performed at 75-140 MW. Tests fired coal above and waste/coal mixture with waste accounting for 9-27% on heat input basis. Measurements included: total particulate, particulate size distribution, O_2, CO_2, CO, NO, SO_2, Cl, Hg in-situ fly ash resistivity and ESP performance.
EPA Research Grant No. R800055	Vaughn, D.A., Krause, H.H., Boyd, W.K. Battelle Columbus Lab.	"A Study of Corrosion in Municipal Incinerators Versus Refuse Composition"	June 1974	To determine the effects of refuse composition (chlorine and sulfur) on fireside corrosion of nine alloy and two protective coating materials	Report on 1st year results of laboratory research. Increasing amounts of sulfur in fuel resulted in reduced corrosion rates.
EPA-SW-530-880 NTIS PB-239-392/4ST	Tunnah, B.G., Hakki, A., and Leonard, R.J. Gordian Associates	"Where the Boilers Are. A Survey of Electric Utility Boilers with Potential Capacity for Burning Solid Waste as Fuel"	1974	To present information which is intended to help decision making for using RDF as supplementary fuel	Details given on: 1) boiler characteristics 2) energy requirements for electricity generation 3) RDF potential on an area by area basis 4) transportation distances from waste production centers to boilers 5) potential waste burning capacities
EPA-650/2-75/044 NTIS PB-243-634/35T	Shannon, L.J., Fiscus, D.E., and Cormany, P.G. Midwest Research Institute	"St. Louis Refuse Processing Plant: Equipment Facitility, and Environmental Evaluation"	May 1975	To evaluate the equipment, facilities and environmental assessment at both the refuse processing plant and the refuse firing plant	See objectives
EPA Research Grant No. R804008-2	Vaughn, D.A., et. al. Battelle Columbus Lab.	"Environmental Effects of Utilizing Solid Waste as a Supplementary Power Plant Fuel"	June 1975	To evaluate the utilization of solid waste as a supplementary fuel at the Columbus, Ohio municipal light plant	Report emphasizes environmental impact, boiler tube corrosivity and combustion behavior as a function of refuse-to-coal ratios for coals having high and low sulfur contents.
EPA Contract No. 68-01-2966	Ottinger, et. al. TRW	"Destructing Chemical Wastes in Commercial Scale Incinerators. Volume 1 - Technical Summary"	July 1975	To develop a set of test plans matching selected commercial scale incineration facilities with selected wastes to demonstrate the technical and economic feasibility of thermal destruction as a means of disposing of organic chemical wastes.	Fifty wastes with emphasis on hazardous wastes are classified, identified, and prioritized. Facilities for commercial scale destruction are selected based on engineering analyses of thermal destruction. Economics for each test are estimated, and a sampling and analysis strategy is developed.

TABLE 3. (Continued)

Report #	Author	Title	Date	Objectives	Accomplishments
EPA Contract No. 68-01-2956	Shih, C.C., Dal Porto, D.F. TRW	"Handbook for Pesticide Disposal by Common Chemical Methods"	October 1975	To develop procedures so that readily available chemical methods for pesticide disposal are used safely	Twenty representative pesticides were selected; practical chemical degradation/detoxification methods were identified and procedures for pesticide disposal were developed.
EPA Contract No. 68-01-1587	Whitmore, F.C. Versar, Inc.	"A Study of Pesticide Disposal in a Sewage Sludge Incinerator"	1975	To demonstrate that a modern sewage sludge incinerator fitted with appropriate air pollution control devices could be used to successfully destroy typical organic pesticides	Tests were conducted on DDT and 2, 4, 5T in two phases: 1) prototype tests in the Envirotech Corp. 76 cm. six-hearth furnace at Brisbane, CA. 2) full scale experiments on Palo Alto, CA., municipal multiple hearth incinerator. Results include destruction efficiencies for DDT > 99.96% and for 2, 4, 5-T >99.95%. Destruction efficiencies were not found to vary greatly over the sludge/pesticide feed ratios studied.
EPA/530/SW - 141	Scurlock, A.C., Lindsey, A.W., Fields, T., Jr. Huber, D.R. EPA	"Incineration in Hazardous Waste Management"	1975	To present an overview of incineration technology as it applies to hazardous waste management	Several incinerator types are reviewed and a matrix matching wastes to incinerator types is presented.
EPA 6001 2-76-208	Ana, K.P.	"Fine Shredding of Municipal Solid Waste"	July 1976	To evaluate the economics of fine shredding of refuse as it relates to combined firing.	See objectives
NATO/CCMS-62 NTIS # PB-276 555	Committee on the Challenges of Modern Society, NATO.	"Recommended Procedures for Hazardous Waste Management"	June 1977	To evaluate various issues that arise from implementation of integrated hazardous waste programs by a country.	Topics considered are: 1) Identification of hazardous wastes. 2) Sampling and analysis of hazardous wastes. 3) Site selection. 4) Long-term care of "managed" wastes.
EPA/530/SW-151c NTIS # PB-278 059	Genser, J.M., Zipperstein, A.H., Klosky, S.P., Farber, P.S. Process Research	"Alternatives for Hazardous Waste Management in the Organic Chemical, Pesticides and Explosives Industries"	September 1977	To review, compare, and recommend promising alternative treatment processes to incineration and land disposal for 24 specific hazardous wastes. The study focuses on processes which haven't been applied on a commercial scale.	Several alternatives for waste handling falling under the categories of physical, chemical, and biological unit treatment are shown to be technologically and economically feasible for some wastes.

TABLE 3. (Continued)

Report #	Author	Title	Date	Objectives	Accomplishments
EPA-600/2-77-196	Clausen, J.F., et. al. TRW	"At-Sea Incineration of Organochlorine Wastes On-board the M/T Vulcanus"	September 1977	To employ recent technology for monitoring and assessing the environmental effectiveness of the disposal process. This includes an evaluation of the adequacy and reliability of the monitoring and sampling system. To acquire sufficiently comprehensive to support the development of regulations and guidelines for future incineration vessels.	Results indicate that incineration performance on the M/T Vulcanus was >99.9% for both organochlorine waste and total organic destruction efficiency. Although monitoring equipment was adequate for this short experiment (approx. 187 hours at 22 tonnes per hour) there is better equipment designed for the unique environment of incineration at sea.
EPA-600/2-78-086	Ackerman, D.G., et. al. TRW	"At-Sea Incineration of Herbicide Orange On-board the M/T Vulcanus"	April 1978	To destroy approximately 10,400 metric tons of herbicide orange on-board the M/T Vulcanus. Furthermore, to determine the adequacy of the sample trains for acquiring data.	Incineration efficiency was >99.9% and the on-line analyzer equipment was judged to be adequate. It was found that wall effects on the combustion effluent gas composition were nonexistent at distances greater than 10 cm from the inside incinerator wall surface.
EPA-600/2-78-087	Paige, S.F., et. al. TRW	"Environmental Assessment: At-Sea and Land-based Incineration of Organochlorine Wastes"	April 1978	To provide a generalized description of the environmental impact associated with each system. The approach includes: (1) identification of combustion products generated by organochlorine incineration at land-based and at-sea facilities; (2) general characterization of the transport and fate of these materials within air, water, and land environments; (3) identification and prediction of general environmental impacts that may result from the effects of these combustion products.	Several differences in the environmental impacts of land-based and at-sea incineration of hazardous wastes are identified: 1) Periodic malfunction results in greater environmental impact on land-based systems. 2) Land-based facilities utilizing alkaline scrubbing water may contribute additional total dissolved solids to the water resources. 3) At-sea incineration can be accomplished at a faster rate. Various data gaps are also identified.
EPA-600/2-78-190	Shih, C.C., et. al. TRW	Comparative Cost Analysis and Environmental Assessment for Disposal of Organochlorine Wastes	August 1978	To compare the costs and environmental impacts associated with the disposal of liquid organochlorine wastes by land-based incineration, at-sea incineration, and chlorolysis at a Houston, Texas location.	All three methods are shown to be economically and environmentally acceptable, with at-sea incineration the least costly. The only environmental problem deals with high particulate wastewater from land-based incinerators and chlorolysis units.

TABLE 3. (Continued)

Report #	Author	Title	Date	Objectives	Accomplishments
EPA Contract No. 68-01-2966	Shih, C.C., Johnson, R.J., et al. TRW	Destroying Chemical Wastes in Commercial Scale Incinerators. Final Report - Phase II	November 1977	To test various commercial scale incinerators for thermal destruction of various chemical wastes.	Six Types of incinerators and 14 types of waste were tested. 13 were found to be effectively destroyed by the type of facility selected for their waste. The facilities tested were: (1) liquid injection; (2) pyrolysis; (3) cement kiln; (4) fluidized bed; (5) wet air oxidation; and (6) rotary kiln. The type of wastes were: (1) ethylene wastes; (2) hexachlorocyclopentadiene waste; (3) nitrochlorobenzene; (4) chlorinated aromatics; (5) polychlorinated biphenyls; (6) styrene wastes; (7) phenol waste; (8) methyl methacrylate; (9) coke plant; (10) ambien; (11) API separator bottoms; (12) polyvinyl chloride waste; (13) rubber waste; and (14) PBCs in capacitors.
EPA-600/2-78-183	Wilkinson, R.P., Kelso, G.L., Hopkins, F.C. Midwest Research Institute	"State-of-the-Art Report - Pesticide Disposal Research"	September 1978	To review published and unpublished information on recent and ongoing research and development on pesticide disposal or conversion methods. Methods for disposal were categorized into four approaches: incineration, physical/chemical treatment, biological methods, and land disposal.	Incineration was found to be the most highly developed, successful method for pesticide disposal. In well designed incinerators ≥99.9% destruction efficiency can be achieved. Incineration was found to be both capital- and energy-intensive. Potential environmental effects are not known. Data base for large scale incinerators, certain types of pesticides, and economics needs to be expanded.
EPA-600/2-79-198	Manson, L., Unger, S. TRW	Hazardous Material Incinerator Design Criteria	October 1979	To evaluate the available basis for the prediction of destruction efficiencies of hazardous wastes in large commercial incinerators.	Design criteria for liquid injection, rotary kiln, fluidized bed, and multiple hearth incinerators are discussed. Various data gaps and research needs are identified. Incinerator scale-up procedures are discussed.

Report #	Contractor	Title	Program Objectives
EPA Contract No. 68-03-2515	MB Associates	"Mobile Incineration Unit: Development"	To design, construct, evaluate, and demonstrate under field-use conditions, a mobile detoxification/incineration system for the on-site processing of non-reuseable or non-recoverable wastes from the cleanup of hazardous material and oil spills.
EPA Contract No. 68-03-2679	Versar, Inc.	"Parametric Evaluations of a Field Scale Hazardous Waste Incinerator"	To conduct parametric investigations on a thermal disposal technology for a variety of hazardous wastes. Data will be developed for incinerator design capabilities, efficiency of various air pollution control devices, material handling problems, and suggested alternate disposal solutions to difficult waste streams.

Research then emphasized the destruction of hazardous wastes in commercial scale incineration facilities. Although this research was land-based not sea-based, the information gathered is important in determining the best incinerator for a specific type of hazardous waste and potential problem areas. In one project (EPA 68-01-2966), wastes were categorized as to their suitability for destruction according to several criteria: physical form of waste (liquid, solid, sludge), temperature required for destruction, composition of off-gases, type of ash (fusible, nonfusible, or metallic) and heating value of waste. Different incineration facilities (liquid injection, rotary kiln, fluidized bed, multiple hearth, etc.) were matched to particular wastes based on engineering analyses of the thermal destruction process. Consequently, the destruction efficiency of several types of incinerators for different types of wastes was determined. It was found that high destruction efficiencies can be achieved for many waste compounds when properly incinerated. Other reports (EPA 68-01-1587 and EPA 530/SW-141) also discussed the matching of hazardous wastes and incinerator types. Various issues such as identification of hazardous wastes, sampling, and site selection that arise during a hazardous waste disposal program were identified in NATO/CCMS-62. Alternative treatment processes to incineration and land disposal such as physical, chemical, and biological treatment were reviewed for specific hazardous wastes in EPA-530/SW-151c.

The literature then focused on at-sea incineration of hazardous wastes. Actual at-sea incineration onboard ship of organochlorine wastes and herbicide orange was monitored and the environmental effectiveness of the incineration process assessed (EPA-600/2-77-196 and EPA-600/2-78-086). Results indicated that combustion efficiencies of greater than 99.9% were achieved. In addition, reliable operation of the sampling and monitoring systems (previously utilized in land-based incineration facilities) in the more harsh environment encountered at sea was demonstrated. Only liquids were incinerated and no scrubber was used on the effluents during the at-sea incinerations. The proposed offshore incineration platform will be handling solids as well as liquids, and will include a scrubber to be used for selected research burns or during adverse meteorological conditions.

The environmental impact of at-sea and land-based incineration of hazardous wastes was considered in EPA-600/2-78-087. The combustion products were identified, the transport and fate of these materials within air, water, and land environments were determined, and the impact on the environment was predicted. Land-based incineration had the greater environmental impact. When the cost of at-sea and land-based incineration was compared (EPA-600/2-78-190), at-sea incineration was less costly. However, when at-sea incineration was compared with landfill disposal methods (EPA-68-01-2966), at-sea incineration was more expensive. The cost of incineration indicates that at-sea thermal destruction should be utilized principally for those chemical wastes which contain hazardous compounds for which other less expensive land-based methods of treatment or disposal are restricted either by regulations or by environmental considerations.

Also in EPA Report 68-01-2966, six types of commercial scale incinerators were tested on various chemical wastes. The incinerators used were liquid injection, pyrolysis, cement kiln, fluidized bed, wet air oxidation, and rotary kiln. The wastes incinerated included organic liquids, aqueous liquids, and sludges and solids. Sampling systems were developed to monitor both waste destruction efficiencies and the environmental impact from incineration. Off-gases were monitored for oxides of carbon and nitrogen, halogens, sulfur compounds, phosphates, volatile metal species, hydrocarbons, and water vapor. The ash was also analyzed as was the wastewater from scrubbing operations.

Four of the six incineration systems (liquid injection, fluidized bed, wet air oxidation, and rotary kiln) used scrubbers to control effluents. Scrubbers were found to minimize the environmental impact from incineration, and to be particularly effective when destroying organochlorine wastes (over 99% removal of HCl).

Although all systems with the exception of wet air oxidation incineration achieved greater than 99.9% destruction efficiency, the rotary kiln was the most versatile for thermal destruction of a wide variety of waste materials. EPA Report 600/2-79-198 which reviewed four incinerators (liquid injection, fluidized bed, multiple hearth, and rotary kiln) also concluded that the rotary kiln was the most widely applicable device for hazardous waste incineration.

The Environmental Protection Agency has also sponsored the development of hazardous waste incinerators (EPA 68-03-2515). One novel approach being developed is a mobile rotary kiln incinerator which can be moved from site to site by truck for processing wastes from the cleanup of hazardous material and oil spills.

The literature review showed that incineration appears to be the most likely method available for the large-scale destruction of hazardous organic wastes and that offshore or at-sea incineration is preferred to land-based incineration. Of the incineration processes reviewed, rotary kiln incineration appeared to be the most versatile. It represented proven technology that can incinerate solids (including explosives), liquids (including chemical warfare agents), gases, sludges and tars. The Rollins incineration system built by Combustion Engineering was chosen for the offshore incineration platform because it represents the best documented rotary kiln technology.

The Rollins incineration system consists of a rotary kiln and a liquid injection burner, both feeding a common afterburner. The afterburner provides additional residence time at temperatures sufficient to insure efficient destruction. Solid wastes, usually packed in fiber drums, are fed into the rotary kiln by a conveyor. Liquids and sludges may also be pumped into the kiln. Liquid wastes are fed directly from tank trucks into the liquid injection burner. For a kiln 4.9 meters (16 ft) long and 3.2 meters (10.25 ft) in diameter, maximum total heat release is 28 million kcal/hr (111 MM Btu/hr). The flame temperature in the kiln is nominally 1300°C (2400°F), and the flame temperature in the liquid burner is approximately 1500°C (2700°F). The afterburner gas temperature is typically 1300°C (2400°F). Overall retention time of the incineration system is from two to three seconds. Stack emissions are controlled by a venturi scrubber. Lime slurry is injected to neutralize the scrubber water. The scrubber is normally operated so as to remove all but submicron particles. At a pressure drop of 40 inches of water, the scrubbing efficiency is 99.5%.

3.2 U.S. COAST GUARD SPILL DATA

As part of the literature search to identify operational disposal needs, computer stored data were requested from the USCG Pollution Incident Reporting System (PIRS). Listings were received for spills of all substances other than oil in the United States, U. S. territories, and coastal waters for the years 1975-1978. The data included information on source, quantity spilled, amount recovered, location, and product. Less than 3500 gallons out of 7.7 million gallons spilled were recovered.

Tables 4 through 7 present information from the PIRS for 1975-1978, respectively. Number of spills and quantities spilled are listed for "hazardous material other than oil" (sand, salt water, etc., were deleted). Spills of materials greater than 10,000 or 100,000 or 1,000,000 gallons are identified by the footnotes for each table. Use of the PIRS data for evaluating incineration needs is limited because a large volume of spill material is listed only as "other hazardous substances". Inputs to the data system were limited to 212 different chemical compounds for the period 1975-1978.

Many of the major spills listed in Tables 4 through 7 are acids and caustics which cannot be incinerated. Minor spills of many incinerable common organic solvents and monomers such as acetone, benzene, toluene, methyl methacrylate, and vinyl acetate are also listed in these tables. The only major spills (>10,000 gallons/yr) of incinerable materials are of formaldehyde, acrylonitrile, phenol, styrene monomer, xylene, ethylene dichloride, and methyl alcohol. No trends are evident in the amount or type of material spilled each year, i.e., a spill of over 1 million gallons of methyl alcohol occurred in 1978, while spills of this material ranged from 0 to 250 gallons in 1975-1977.

The PIRS data indicate that 5.3 million gallons, or 69 percent of the 7.7 million gallons of hazardous material spilled during 1975-1978, were located in the Gulf of Mexico and neighboring states. An increasing

TABLE 4. SPILLS OF HAZARDOUS MATERIAL FOR 1975
(USCG POLLUTION INCIDENT REPORTING SYSTEM DATA)

	MATERIAL	ALL SPILLS NO.	ALL SPILLS GALLONS	SPILLS NO.	<55 GAL GALLONS	SPILLS NO.	>55 GAL GALLONS	UNK[(1)] NO.
	ACETONE	1	.0	0	.0	0	.0	1
	ACRYLONITRILE	3	136.0	1	10.0	1	126.0	1
	AMMONIA (28 PERCT AQUEOUS)	6	5215.0	1	5.0	4	5210.0	1
	BENZENE	2	10.0	2	10.0	0	.0	0
	CARBON TETRACHLORIDE	1	500.0	0	.0	1	500.0	0
X	CAUSTIC SODA	9	26514.0	6	114.0	3	26400.0	0
	CRESOLS	5	32.0	5	32.0	0	.0	0
	CYCLO-HEXANE	1	1.0	1	1.0	0	.0	0
	EPICHLOROHYDRIN	1	.0	0	.0	0	.0	1
	ETHYL ACRYLATE	1	3.0	1	3.0	0	.0	0
	GLYCOL	1	15.0	1	15.0	0	.0	0
X	HYDROCHLORIC ACID	7	26011.0	2	11.0	5	26000.0	0
	METHYL ALCOHOL	2	151.0	1	1.0	1	150.0	0
	METHYL METHACRYLATE	1	110.0	0	.0	1	110.0	0
	OLEUM	1	150.0	0	.0	1	150.0	0
XX	OTHER HAZARDOUS SUBSTANCE[(2)]	78	304259.1	31	625.1	31	303634.0	16
	PERCHLOROETHYLENE	1	50.0	1	50.0	0	.0	0
	PHENOL	3	1050.0	2	50.0	1	1000.0	0
X	PHOSPHORIC ACID	3	17800.0	0	.0	3	17800.0	0
	STYRENE MONOMER	9	1060.0	4	70.0	4	990.0	1
X	SULPHURIC ACID	13	16306.0	2	62.0	10	16244.0	1
	TOLUENE	12	1483.0	5	95.0	7	1388.0	0
	VINYL ACETATE	1	100.0	0	.0	1	100.0	0
	XYLENE	13	546.0	10	126.0	2	420.0	1
	TOTAL	175	401502.1	76	1280.1	76	400222.0	23

X ≥ 10,000 GALLONS
XX ≥ 100,000 GALLONS
(1) UNKNOWN QUANTITY SPILLED
(2) NOT FURTHER IDENTIFIED IN DATA

TABLE 5. SPILLS OF HAZARDOUS MATERIAL FOR 1976
(USCG POLLUTION INCIDENT REPORTING SYSTEM DATA)

MATERIAL	ALL SPILLS NO.	ALL SPILLS GALLONS	SPILLS NO.	< 55 GAL GALLONS	SPILLS NO.	≥ 55 GAL GALLONS	UNK(1) NO.
ACETALDEHYDE	2	200.0	0	.0	1	200.0	1
X ACETIC ACID	4	31005.0	1	5.0	2	31000.0	1
ACETONE	2	594.0	1	5.0	1	589.0	0
ACRYLIC ACID	2	2500.0	0	.0	1	2500.0	1
ALUMINUM SULFATE	1	1000.0	0	.0	1	1000.0	0
X AMMONIA (28 PERCT AQUEOUS)	5	26005.0	1	5.0	2	26000.0	2
AMMONIUM COMP.	1	3025.0	0	.0	1	3025.0	0
BENZENE	16	3603.0	14	201.0	1	3402.0	1
CALCIUM COMP.	3	1105.0	2	55.0	1	1050.0	0
CAUSTIC SODA	6	1029.0	2	4.0	2	1025.0	2
CHLORINE	2	4.0	1	4.0	0	.0	1
CHLOROFORM	2	4000.0	0	.0	1	4000.0	1
CHROMIUM COMP.	1	.0	0	.0	0	.0	1
CRESOLS	3	22.0	3	22.0	0	.0	0
CYANIDE COMP.	2	175.0	1	10.0	1	165.0	0
CYCLO-HEXANE	3	1040.0	2	40.0	1	1000.0	0
ETHYL ALCOHOL	1	30.0	1	30.0	0	.0	0
ETHYLBENZENE	2	40.0	2	40.0	0	.0	0
ETHYLENE CYANOHYDRIN	1	84.0	0	.0	1	84.0	0
ETHYLENE DICHLORIDE	2	55.0	2	55.0	0	.0	0
X FORMALDAHYDE	1	23000.0	0	.0	1	23000.0	0
GLYCOL	1	.0	0	.0	0	.0	1
X HYDROCHLORIC ACID	11	16453.0	4	153.0	7	16300.0	0
X HYDROGEN PEROXIDE	1	10000.0	0	.0	1	10000.0	0
IRON COMP	3	10.0	1	10.0	0	.0	2
ISOPROPYL ALCOHOL	3	57.0	3	57.0	0	.0	0
LIQUID SULPHUR	1	42.0	1	42.0	0	.0	0
METHYL ISO-BUTYL KETONE	1	.0	0	.0	0	.0	1
METHYL ALCOHOL	3	251.0	1	1.0	1	250.0	1
METHYL METHACRYLATE	1	50.0	1	50.0	0	.0	0
N-BUTYL ACETATE	1	3000.0	0	.0	1	3000.0	0
NAPTHALENE	2	101.0	1	1.0	1	100.0	0
OLEUM	1	.0	0	.0	0	.0	1
XXX OTHER HAZARDOUS SUBSTANCE(2)	72	1692550.1	18	393.1	36	1692157.0	18
PENTACHLOROPHENOL	1	2800.0	0	.0	1	2800.0	0
PHENOL	4	1072.0	2	8.0	2	1064.0	0
X PHOSPHORIC ACID	4	11002.0	1	2.0	2	11000.0	1
PROPIONIC ACID	2	3500.0	0	.0	1	3500.0	1
SODIUM HYDROSULFIDE	1	4500.0	0	.0	1	4500.0	0
SODIUM HYDROXIDE	4	3105.0	1	25.0	3	3080.0	0
STRYCHNINE	1	1.0	1	1.0	0	.0	0
STYRENE MONOMER	4	2940.0	0	.0	3	2940.0	1
SULFUR MONOCHLORIDE	1	500.0	0	.0	1	500.0	0
XX SULPHURIC ACID	21	340635.0	6	117.0	13	340518.0	2
TOLUENE	11	850.0	9	150.1	2	700.0	0
TOXAPHENE	1	90.0	0	.0	1	90.0	0
TRICHLORETHYLENE	1	.0	0	.0	0	.0	1
VINYL ACETATE	1	10.0	1	10.0	0	.0	0
XYLENE	14	603.0	8	78.0	1	525.0	5
ZINC COMP.	1	30.0	1	30.0	0	.0	0
2773	1	.0	0	.0	0	.0	1
TOTAL	236	2192668.2	93	1604.2	96	2191064.0	47

X ≥ 10,000 GALLONS
XX ≥ 100,000 GALLONS
XXX ≥ *1,000,000 GALLONS*
(1) UNKNOWN QUANTITY SPILLED
(2) NOT FURTHER IDENTIFIED IN DATA

TABLE 6. SPILLS OF HAZARDOUS MATERIAL FOR 1977
(USCG POLLUTION INCIDENT REPORTING SYSTEM DATA)

	MATERIAL	ALL SPILLS NO.	ALL SPILLS GALLONS	SPILLS NO.	<55 GAL GALLONS	SPILLS NO.	≥55 GAL GALLONS	UNK(1) NO.
	ACETIC ACID	3	3010.0	2	10.0	1	3000.0	0
X	ACETIC ANHYDRIDE	1	10000.0	0	.0	1	10000.0	0
	ACETONE	2	50.0	1	50.0	0	.0	1
	ACRYLIC ACID	1	150.0	0	.0	1	150.0	0
XX	ACRYLONITRILE	2	103100.0	0	.0	2	103100.0	0
	AMMONIA (28 PERCT AQUEOUS)	4	10.0	1	10.0	0	.0	3
	AMMONIUM COMP.	2	6035.0	1	35.0	1	6000.0	0
	BENZENE	15	553.0	9	243.0	3	310.0	3
	BROMINE	1	500.0	0	.0	1	500.0	0
	CALCIUM COMP.	1	100.0	0	.0	1	100.0	0
	CARBON TETRACHLORIDE	1	7000.0	0	.0	1	7000.0	0
	CAUSTIC SODA	15	7189.0	5	109.0	4	7080.0	6
	CHLORINE	2	500.0	0	.0	1	500.0	1
	CHROMIUM COMP.	1	.0	0	.0	0	.0	1
	COPPER COMP.	3	591.3	2	19.3	1	572.0	0
	CRESOLS	1	.0	0	.0	0	.0	1
	CYANIDE COMP.	1	.0	0	.0	0	.0	1
	CYCLO-HEXANE	5	69.0	5	69.0	0	.0	0
	DICHLOROPROPANE	1	50.0	1	50.0	0	.0	0
	ETHYL ACRYLATE	3	21.0	3	21.0	0	.0	0
	ETHYL ALCOHOL	1	30.0	1	30.0	0	.0	0
XX	ETHYLENE DICHLORIDE	2	290000.0	0	.0	1	290000.0	1
	GLYCOL	4	516.0	3	16.0	1	500.0	0
	HYDROCHLORIC ACID	2	630.0	1	30.0	1	600.0	0
	HYDROFLUORIC ACID	1	1500.0	0	.0	1	1500.0	0
	IRON COMP	1	.0	0	.0	0	.0	1
	ISOPROPYL ALCOHOL	1	.0	0	.0	0	.0	1
	MERCURY COMP.	1	.0	0	.0	0	.0	1
XXX	METHYL ALCOHOL	1	1260000.0	0	.0	1	1260000.0	0
	METHYL ETHYL KETONE	2	104.0	1	20.0	1	84.0	0
	NAPTHALENE	3	4526.0	2	26.0	1	4500.0	0
	NITROGEN DIOXIDE	1	2000.0	0	.0	1	2000.0	0
XXX	OTHER HAZARDOUS SUBSTANCE(2)	50	1909683.0	13	131.0	20	1909552.0	17
	PHOSPHORIC ACID	2	100.0	0	.0	1	100.0	1
	POTASSIUM PERMANGANATE	3	730.0	0	.0	3	730.0	0
X	SODIUM HYDROXIDE	4	46165.0	0	.0	3	46165.0	1
	SODIUM HYDROCHLORITE	1	500.0	0	.0	1	500.0	0
	SODIUM PHOS. MONO.	1	350.0	0	.0	1	350.0	0
XX	STYRENE MONOMER	12	420658.0	7	148.0	5	420510.0	0
	SULFUR MONOCHLORIDE	1	5.0	1	5.0	0	.0	0
XX	SULPHURIC ACID	4	349258.0	1	30.0	2	349228.0	1
	TOLUENE	7	667.0	3	67.0	1	600.0	3
	TRICHLORETHYLENE	1	1500.0	0	.0	1	1500.0	0
	TRICHLOROETHANE	1	50.0	1	50.0	0	.0	0
	VINYL ACETATE	2	30.0	1	30.0	0	.0	1
XX	XYLENE	12	189093.0	11	93.0	1	189000.0	0
	XYLENOL	1	5.0	1	5.0	0	.0	0
	TOTAL	187	4617028.3	77	1297.3	65	4615731.0	45

X ≥ 10,000 GALLONS
XX ≥ 100,000 GALLONS
XXX ≥ 1,000,000 GALLONS
(1) UNKNOWN QUANTITY SPILLED
(2) NOT FURTHER IDENTIFIED IN DATA

TABLE 7. SPILLS OF HAZARDOUS MATERIAL FOR 1978
(USCG POLLUTION INCIDENT REPORTING SYSTEM DATA)

	MATERIAL	ALL SPILLS NO.	ALL SPILLS GALLONS	SPILLS <55 GAL NO.	SPILLS <55 GAL GALLONS	SPILLS ≥55 GAL NO.	SPILLS ≥55 GAL GALLONS	UNK[1] NO.
	ACETIC ACID	3	1000.0	0	.0	1	1000.0	2
	ACETONE	1	25.0	1	25.0	0	.0	0
	ACRYLIC ACID	1	3500.0	0	.0	1	3500.0	0
X	ACRYLONITRILE	1	22800.0	0	.0	1	22800.0	0
	ALUMINUM SULFATE	1	2500.0	0	.0	1	2500.0	0
X	AMMONIA (28 PERCT AQUEOUS)	8	66950.0	3	50.0	3	66900.0	2
	AMMONIUM COMP.	9	1832.5	2	2.5	3	1830.0	3
	BENZENE	16	2093.0	8	161.0	3	1932.0	5
	BROMINE	2	1800.0	0	.0	2	1800.0	0
	BUTRYRIC ACID	1	650.0	0	.0	1	650.0	0
	BUTYLAMINE	1	1.0	1	1.0	0	.0	0
	CARBON TETRACHLORIDE	2	50.0	1	50.0	0	.0	1
	CAUSTIC SODA	5	3150.2	2	50.2	2	3100.0	1
	CHLORINE	4	6.0	2	6.0	0	.0	2
	CHORMIUM COMP.	1	30.0	1	30.0	0	.0	0
	COPPER COMP.	2	600.0	0	.0	1	600.0	1
	CRESOLS	2	5.0	1	5.0	0	.0	1
	CYANIDE COMP.	1	30.0	1	30.0	0	.0	0
	CYCLO-HEXANE	2	2120.0	1	20.0	1	2100.0	0
	ETHYLENE GLYCOL	1	2.0	1	2.0	0	.0	0
	FLOURINE COMP.	1	600.0	0	.0	1	600.0	0
	FORMALDEHYDE	1	100.0	0	.0	1	100.0	0
	HYDROCHLORIC ACID	8	4810.0	1	20.0	5	4790.0	2
	ISOPROPYL ALCOHOL	1	55.0	0	.0	1	55.0	0
	MERCURY COMP.	1	.0	0	.0	0	.0	1
	METHYL ALCOHOL	2	1643.0	1	10.0	1	1633.0	0
	METHYL ETHYL KETONE	1	5.0	1	5.0	0	.0	0
	METHYL ISO-BUTYL KETONE	1	15.0	1	15.0	0	.0	0
	METHYLENE CHLORIDE	1	550.0	0	.0	1	550.0	0
	N-BUTYL ALCOHOL	1	10.0	1	10.0	0	.0	0
	NAPTHALENE	3	26.0	3	26.0	0	.0	0
	NITRIC ACID 90 PERCT	1	250.0	0	.0	1	250.0	0
	NITROGEN DIOXIDE	1	2.0	1	2.0	0	.0	0
XX	OTHER HAZARDOUS SUBSTANCE[2]	51	323353.0	15	300.0	24	323053.0	12
	PCB	1	5.0	1	5.0	0	.0	0
	PERCHLOROETHYLENE	1	.0	0	.0	0	.0	1
X	PHENOL	5	13175.0	1	50.0	2	13125.0	2
	PHOSPHORIC ACID	3	1221.0	1	21.0	2	1200.0	0
	SODIUM HYDROXIDE	2	234.0	1	10.0	1	224.0	0
	SODIUM SULFIDE	1	700.0	0	.0	1	700.0	0
X	STYRENE MONOMER	8	13664.0	3	64.0	5	13600.0	0
	SULPHURIC ACID	16	6453.0	6	169.0	7	6284.0	3
	TOLUENE	12	309.0	9	141.0	1	168.0	2
	TOXAPHENE	1	100.0	0	.0	1	100.0	0
	TRICHLORETHYLENE	2	61.0	1	1.0	1	60.0	0
X	XYLENE	10	12437.0	4	71.0	3	12366.0	3
	ZINC COMP.	2	12.0	2	12.0	0	.0	0
	TOTAL	201	488934.7	78	1364.7	79	487570.0	44

X ≥ 10,000 GALLONS
XX ≥ 100,000 GALLONS
(1) UNKNOWN QUANTITY SPILLED
(2) NOT FURTHER IDENTIFIED IN DATA

proportion of the total volume of material spilled occurred in this area each year: 18 percent in 1975, 27 percent in 1976, 67 percent in 1977, and 94 percent in 1978. A Gulf site would therefore be advantageous for an operational incinerator facility.

3.3 RESEARCH NEEDS AND OPERATIONAL USES

The EPA and U.S. Coast Guard made a preliminary determination that an offshore hazardous waste incinerator could serve two broad functions: first, it would provide a facility for the destruction of hazardous wastes in a location minimizing the risk to public health; second, it would be a safe site to continue EPA's research into hazardous waste incineration. Because at-sea incineration is less expensive than land-based incineration, it is expected that there would also be a commercial demand for the use of an offshore incinerator.

The offshore incinerator could be useful in managing the spills along the Gulf shoreline. Many industrial facilities unable to safely dispose of their own hazardous wastes might utilize an available offshore incineration facility. Although the actual demand for use of an offshore incinerator has not been determined, it can be expected that the incinerator would be used extensively to manage a wide variety of waste materials from many different sources. The demand for use of the offshore incinerator would be dependent on the availability and economics of hazardous waste incineration.

Much of the research in hazardous waste incineration is done with laboratory and pilot scale incinerators. The offshore hazardous waste incinerator would expand the experience in the large scale processing of hazardous waste materials. The effects of operational upsets or process variations in a commercial scale incineration operation on hazardous waste destruction efficiencies and personnel and plant safety needs to be investigated. Corrosion studies to determine which wastes or their by-products will deteriorate the commercial scale equipment can be initiated with the offshore incinerator. Investigations into generation of hazardous intermediate products and destruction optimization studies could be conducted.

The offshore incinerator can also be used to monitor the performance of pollution control equipment. Presently, the effects of incinerating different wastes on scrubber performance is largely unknown. Scrubber performance is usually measured in terms of criteria pollutants, and the offshore incinerator could be used to study the efficiency of scrubbers on toxic organic compounds which appear in the flue gas. The offshore incinerator could also be used for research in process instrumentation and control as they apply to hazardous waste incineration.

The literature search revealed several other data gaps and research needs related to hazardous waste incineration. The heterogeneity and large volume of hazardous wastes generated present a formidable problem in cataloging and characterizing the actual chemical compounds in the wastes. This problem is complicated by the large number of different formulations by different manufacturers. Although much research has been accomplished in hazardous waste incineration, the thermochemistry of only certain types of compounds has been determined. In the case of organic pesticides alone, e.g., destruction criteria have been determined for some chlorinated hydrocarbons and some organophosphates, but destruction criteria for anilides, ureas, uracils, and nitrated hydrocarbons have been largely undetermined.

Midwest Research Institute and the University of Dayton Research Institute have developed laboratory and pilot techniques to efficiently determine the conditions (temperature, residence time) necessary for destruction of hazardous compounds. The relationship between the findings of these laboratory scale studies and commercial scale incineration is subject to speculation. The degree of waste decomposition depends almost entirely on the three T's of incineration: time, temperature, and turbulence. Turbulence refers to mixing and dispersion (e.g., exposing fuel to ozidizer, and contact between solids and gases), and time refers to the residence time of the waste at or above a specified temperature. Although the temperature and time necessary for waste decomposition may be determined in a laboratory reactor, it is likely that the degree and character of turbulence achieved in the laboratory incinerator will be different from that in a commercial incinerator. One of the more promising techniques to bridge the data gap from laboratory to commercial scale incinerators is the mathematical characterization of the incinerators as chemical reactors. However, there are several difficulties which must be overcome in advancing this technique - the first of which was mentioned above; i.e., in order to mathematically model the waste destruction process, the thermochemical kinetics for each compound must be known. The large number of hazardous compounds makes this an exhaustive task. However, a potential definition of similarity between reactors appears in Manson (Table 3). Two geometrically similar incinerators of different capacity are deemed similar if, when burning the same type of waste, they produce the same level of destruction and their stack gases and residues respectively have the same composition. Various dimensionless parameters such as Reynolds, Biot, and Nusselt numbers, might be used to define the similarity between different reactors. Research into these modeling techniques is needed, and the offshore incinerator could serve as a test for various models.

The following is a list of some of the operational uses and research needs which the offshore incinerator could serve:

- Dispose of material containing hazardous constituents from spills, dump sites, etc.
- Conduct incineration tests to establish conditions for safe disposal of specific wastes.
- Investigate the thermochemistry of many hazardous compounds not presently characterized.
- Perform mathematical modeling of large-scale incinerators.
- Evaluate effects of operational upsets on waste destruction efficiency and plant and personnel safety.
- Investigate toxic product generation by incineration and fate of these products (ash, flue gas, etc.).
- Perform corrosion studies with different types of wastes, their products, and materials.
- Evaluate the performance of air-pollution control equipment for toxic organics.
- Perform incinerator instrumentation and process control research, and systems safety analyses.
- Collect economic data for incineration of various materials.

4. EVALUATION OF EXISTING INCINERATION SYSTEMS

In order to select an incinerator design for the offshore platform, an evaluation was made of existing systems capable of incinerating hazardous materials. Both commercial and EPA developed systems were investigated during this study.

4.1 COMMERCIAL SYSTEMS

Existing commercial incineration systems were evaluated for the offshore incineration program. Eight types of thermal destruction systems were found to be most commonly used for destroying hazardous wastes:

- Liquid injection
- Fluidized bed
- Multiple hearth
- Rotary kiln
- Catalytic combustor
- Molten salt pyrolysis/combustion
- Pyrolysis
- Wet oxidation.

In the performance of EPA Contract 68-01-2966, "Destroying Chemical Wastes in Commercial Scale Incinerators," (Table 3), the applicability of the eight types of thermal destruction systems for destroying a wide variety of wastes was investigated. It was concluded that the rotary kiln in conjunction with a liquid injection incinerator (used as an afterburner) represents the most versatile combination for thermal destruction of a wide variety of waste types. The rotary kiln utilizes mechanical mixing which permits the solid or liquid wastes to be exposed to hot oxidizing gas for as long as needed for their destruction. This incinerator is particularly well-suited for the destruction of solids and highly viscuous sludges, including wastes resulting from cleanup of spills (Section 3).

The rotary kiln is also capable of handling wastes which have fusible ash. The liquid injection incinerator also offers excellent mixing so that vaporized waste can be effectively destroyed. Both rotary kilns and liquid injection incinerators are capable of operating at temperatures greater than 1100°C. Consequently, a rotary kiln with a liquid injection afterburner has been selected as the offshore incinerator for this feasibility study.

Several commercial incinerators suitable for destroying hazardous wastes are listed in Table 8. The Combustion Engineering, Inc., Bartlett-Snow "Tumble Burner," the Thermal Reductor System, and the M B Associates mobile incinerator are all rotary kilns with afterburners. The Burn-Zol and Smokatrol incinerators are also capable of burning solids and sludges. Any of these incinerators can be assembled on the offshore platform. Features such as size, cost, etc., are presented in Table 8.

4.2 EPA DEVELOPED SYSTEMS

Two hazardous waste incinerator evaluation programs currently sponsored by EPA were identified (Table 3). One is the mobile field use system for the detoxification/incineration of residual from oil and hazardous material spills. The system consists of a shredder, rotary kiln, afterburner, and gas scrubbing equipment, all mounted on three heavy-duty commercial highway trailers (Figure 2). The EPA/IERL Oil and Hazardous Materials Spills Research Branch, Edison, New Jersey, is sponsoring the development of this system by M B Associates, San Ramon, California, under Contract 68-03-2515. Delivery of the unit for testing is presently scheduled for March 1980. Components of this system were designed specifically to meet the requirements of transportability by trailer. Because an estimated one-third to one-half of the total cost of the mobile incinerator (approximately $1.4 million) is to provide over-the-road transportability, it is not considered cost effective to locate this equipment at a fixed site such as the ocean platform (personal communication with Dr. John E. Brugger, EPA Project Officer for development of the mobile incineration unit). A more conventional commercial incineration system designed for stationary siting, the CE Bartlett-Snow "Tumble Burner," was considered to be more suitable for the offshore platform. A solids shredder such as the one planned for the mobile incinerator was selected for the offshore incineration system.

TABLE 8. SUMMARY OF COMMERCIALLY AVAILABLE INCINERATORS

Incinerator	Type - Features	Capacity lbs/hr (Municipal Refuse)	Capacity Btu/hr (Municipal Refuse)	Size (Feet) Width	Size (Feet) Height	Size (Feet) Length	Weight (lbs)	Cost ($)
Tumble Burner, Combustion Engineering, Inc.	Rotary Kiln	1860	8.9×10^6	12	14	30	200,000	430,000
	Afterburner Wet-Scrubber Pneumatic Feeder	3230	15.5×10^6	14	15	34	260,000	670,000
Thermal Reductor System	Rotary Kiln Afterburner Bag-House Wet-Scrubber Heat Recovery Ram Feeder	1500	7.2×10^6	18-.8	18-.5	56	223,000	400,000
MB Associates	Rotary Kiln Afterburner Scrubber Shredder	2600	12.5×10^6	3 trailers, each 45 x 8			---	---
Burn-Zol	Multichambered Vertical Incinerator	1280	6.1×10^6	Diameter 7.5	Platform Size 8		---	---
	Afterburner Heat Recovery Ram Charger	2310	11.8×10^6	8.5	9		---	---
Smokatrol	Horizontally Aligned Cylinder	1000	6.5×10^6	19.1	22	21.5	43,000	45,000 (not including feeder or liquid injector)
	Afterburner	1500	9.75×10^6	22.9	24	24	---	---
	Waste Heat Recovery	2000	13.0×10^6	24.25	27	25	---	---
	Screw-type Ram	2500	16.25×10^6	25.2	27.5	26	---	---

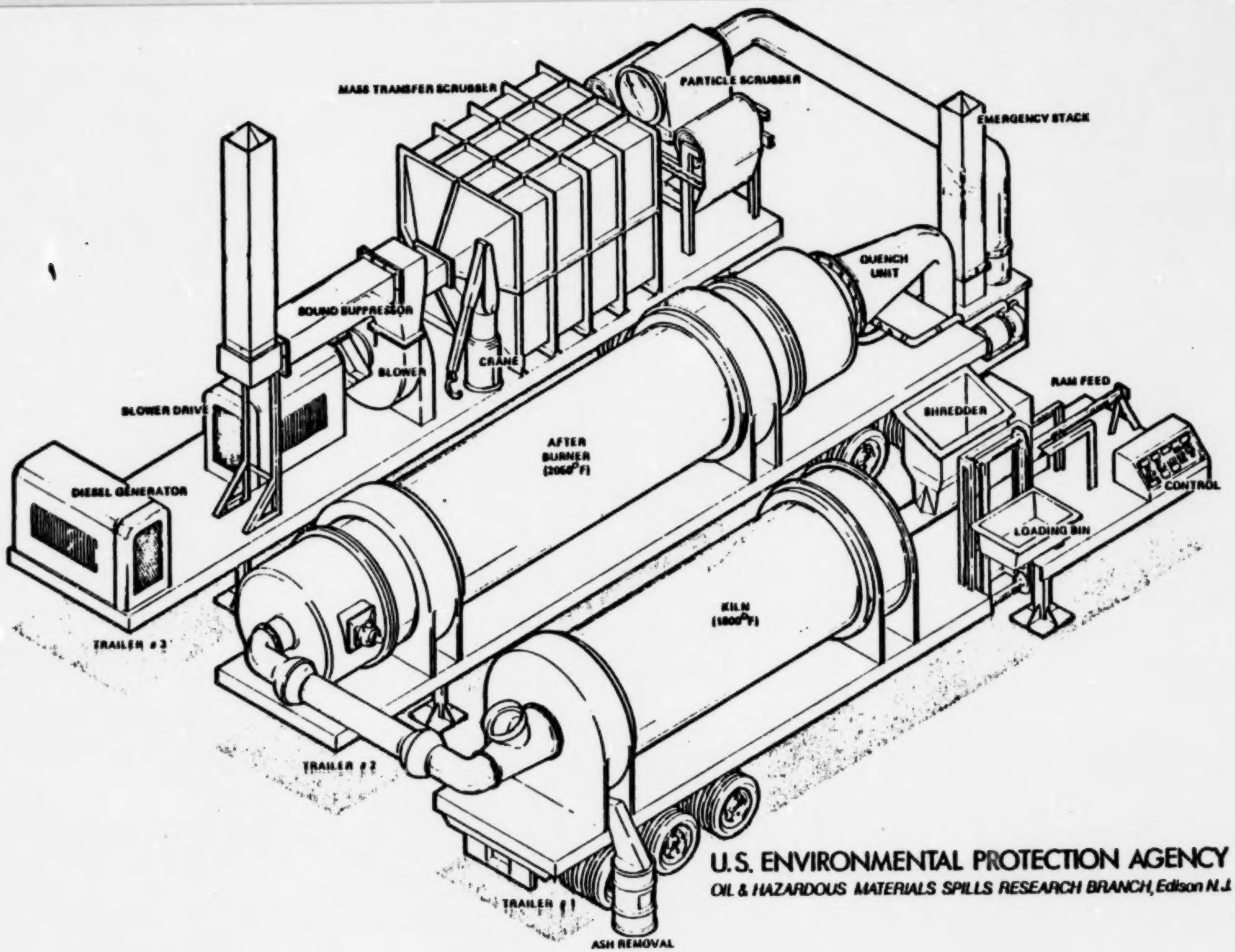
MASS TRANSFER SCRUBBER
PARTICLE SCRUBBER
EMERGENCY STACK
QUENCH UNIT
SOUND SUPPRESSOR
BLOWER
CRANE
BLOWER DRIVE
DIESEL GENERATOR
AFTER BURNER (2060°F)
RAM FEED
SHREDDER
CONTROL
LOADING BIN
KILN (1800°F)
TRAILER # 3
TRAILER # 2
TRAILER # 1
ASH REMOVAL
U.S. ENVIRONMENTAL PROTECTION AGENCY
OIL & HAZARDOUS MATERIALS SPILLS RESEARCH BRANCH, Edison N.J.

Figure 2. Mobile Incineration System

Parametric evaluations of a field-scale hazardous waste incinerator are to be conducted by Versar, Inc. under Contract 68-03-2679, for EPA/MERL Solid and Hazardous Waste Research Division, Cincinnati, Ohio. Incineration tests are to be performed for evaluation of destruction mechanisms for highly hazardous wastes: PCBs, Kepone, organometalics, dioxins, etc. The incineration system consists of a rotary kiln, afterburner, waste heat boiler, and scrubber. Manufacturer of the system is TR (Thermal Reductor) Systems, Bloomfield, Connecticut. TR Systems was contacted for design information applicable to an offshore incineration system (Table 8). Extensive operating experience with the CE "Tumble Burner" at sites such as Rollins Environmental Services, Inc., Deer Park, Texas, led to its selection over the TR Systems incinerator.

5. OFFSHORE INCINERATION SYSTEM

This section describes the conceptual design of an incineration system for the offshore platform; and provides a monitoring plan, a systems operation plan, and a cost analysis for the conceptual incinerator.

5.1 CONCEPTUAL DESIGN

The conceptual incinerator design was based upon existing hazardous waste incineration systems. Commercially available equipment was surveyed in specifying, selecting, and estimating costs of an incinerator for the offshore platform. A rotary kiln incinerator coupled with a high temperature afterburner was selected as the most versatile system, capable of thermally destroying a wide variety of waste materials, including solids, liquids, and slurries.

5.1.1 System Design Criteria

Design criteria for the conceptual incineration system were:

Feed rates - 0.5 to 1.5 metric tons/hr of solid material or 1.5 to 3.0 metric tons/hr of liquids and pumpable slurries; combined solid/liquid feed rates up to a total heat input of approximately 40,000,000 Btu/hr (actual feed rates are dependent on heating value and moisture content of the specific material).

Shredder - capable of processing solid wastes, 55 gallon drums, soft metals, fence posts, small logs, shrubs, etc.; enclosed to control fumes.

Rotary kiln - operating temperature of 1000 to 1300°C, up to 1 hour solids residence time, negative pressure to minimize fugitive emissions.

Afterburner - operating temperature of 1300 to 1500°C, above 2 seconds gas residence time, 3% O_2 or greater (exceed Federal Regulation requirements for incineration of PCBs), negative pressure.

Quench section - seawater injected to cool combustion gases to 300°C, allowing use of standard materials and bearings for induced draft fan. Quench water piped back below ocean surface and dispersed to minimize marine environmental effects.

Scrubber section - single pass seawater scrubber used only when adverse meteorological conditions cause plume impingement on platform, or for selected research burns. Water flow rate of 125 m^3/hr (550 gpm), pressure drop variable from 64 to 100 cm H_2O (25 to 40" H_2O). Combustion gases will be diverted through the scrubber instead of passing directly from the quench section to the stack. Scrubber water will also be dispersed below the ocean surface.

Induced draft fans - used to provide combustion gas flow through the incineration system. Normally, only the quench system ID fan will be operated, at a pressure drop of 25 cm H_2O (10" H_2O). When the scrubber is operating, a second ID fan will be used to overcome the increased pressure drop. Volumetric gas flow is 26,500 m^3/hr.

Exhaust stack - combustion gases from the quence section or the scrubber will be exhausted through a 15 meter (50 ft) high stack. Stack height to be greater than 2.5 times the height of nearby support buildings to preclude "downwash" of the plume.

Control/data acquisition system - both incinerator process control functions and data acquisition will be performed by a single digital computer system. A modular system will be used to allow component replacement by spares rather than requiring on-site repairs. Process controls will incorporate safety interlocks, programmed start-up and shutdown cycles, and warning alarms. Combustion efficiency will be continuously calculated and displayed along with all process parameters and air pollutant monitoring data.

5.1.2 Selected System Design

The incineration system design selected for the offshore platform is shown schematically in Figure 3. The basic incinerator selected is the Bartlett-Snow "Tumble Burner," Model #12, manufactured by Combustion Engineering, Inc. This size unit is used for incineration of chemical wastes at a number of industrial plants and waste disposal facilities, including Rollins Environmental Services, Inc., sites at Bridgeport, New Jersey, Baton Rouge, Louisiana, and Deer Park, Texas. A hydraulic-driven, shear type shredder, capable of processing 55-gallon drums filled with solidified wastes, is available from Saturn Manufacturing, Inc., Wilsonville, Oregon.

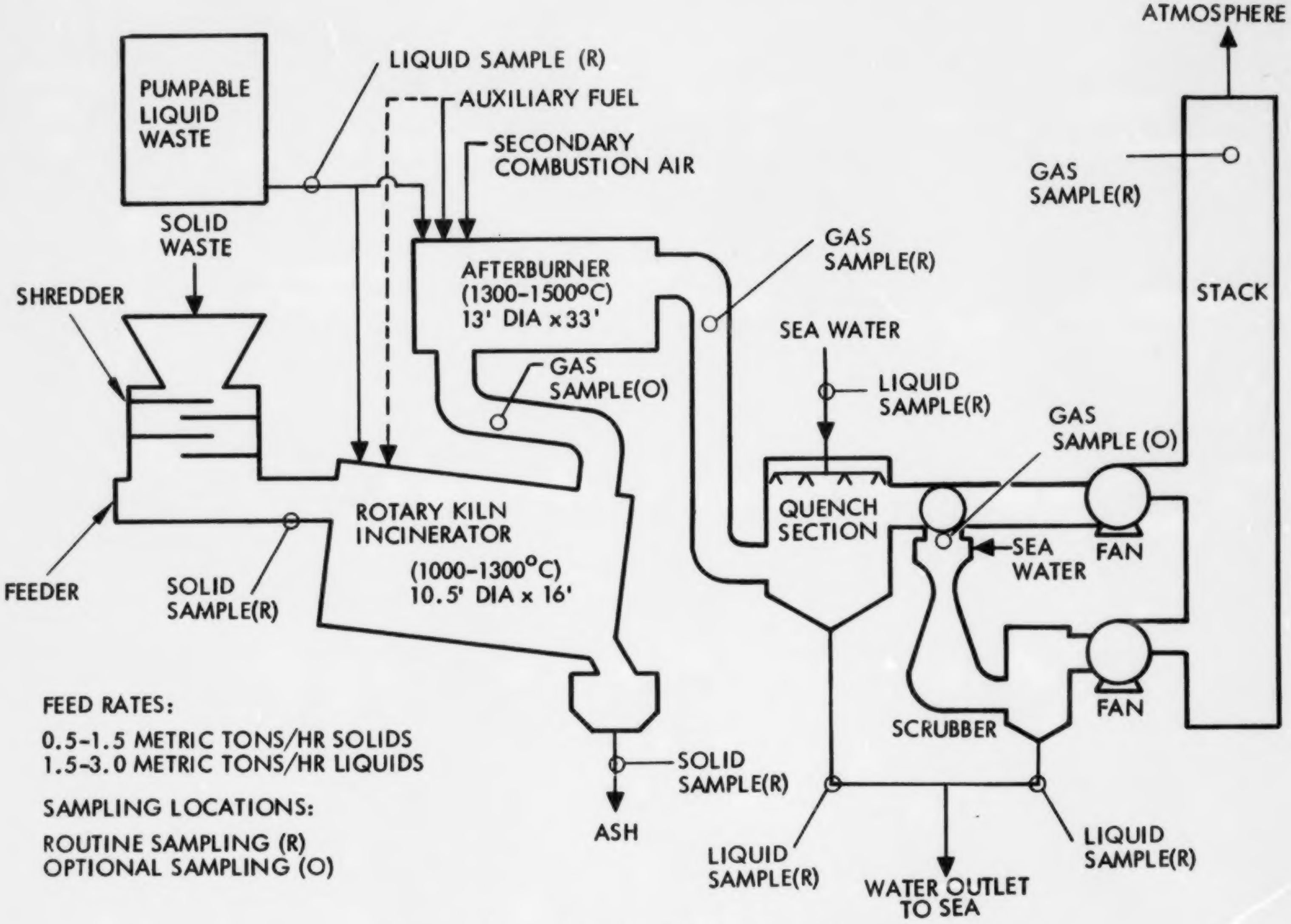
ATMOSPHERE
PUMPABLE LIQUID WASTE
LIQUID SAMPLE (R)
AUXILIARY FUEL
SECONDARY COMBUSTION AIR
GAS SAMPLE(R)
SOLID WASTE
SHREDDER
AFTERBURNER (1300-1500°C) 13' DIA x 33'
GAS SAMPLE(R)
STACK
SEA WATER
GAS SAMPLE(O)
LIQUID SAMPLE(R)
GAS SAMPLE (O)
QUENCH SECTION
ROTARY KILN INCINERATOR
SEA WATER
FAN
FEEDER
(1000-1300°C) 10.5' DIA x 16'
SOLID SAMPLE(R)
FAN
SCRUBBER
FEED RATES:
0.5-1.5 METRIC TONS/HR SOLIDS
1.5-3.0 METRIC TONS/HR LIQUIDS
SOLID SAMPLE(R)
SAMPLING LOCATIONS:
ROUTINE SAMPLING (R)
OPTIONAL SAMPLING (O)
ASH
LIQUID SAMPLE(R)
LIQUID SAMPLE(R)
WATER OUTLET TO SEA

Figure 3. Conceptual Incineration Schematic

As shown in Figure 3, solid wastes are shredded and fed into the rotary kiln. Fumes from the shredder enclosure also pass into the kiln. Pumpable liquid wastes can be fed into either the kiln or the afterburner, along with auxiliary fuel as required to supplement the heat content of the waste material. After cooling by the quench section, combustion gases are normally ducted directly to the exhaust stack, but may be diverted through a scrubber when desired for research needs or environmental safety considerations.

Locations for acquisition of incinerator feed and effluent samples are also shown in Figure 3. Routine and optional sampling are described in the incineration monitoring plan presented in the following section.

The proposed incinerator control/data acquisition system is shown in block diagram form in Figure 4. This system meets all of the design criteria discussed in Section 5.1.1. Modular components can be replaced by spares rather than repaired on-site. Both process parameters (pressures, temperatures, flow rates, etc.) and on-line data (CO, CO_2, O_2, etc.) are input to the computer which can be programmed to control start-up and shutdown sequences automatically, and to initiate warning signals and/or shutdown when preset limits are reached, such as low temperatures, draft loss, quench water loss, etc. Advantages of this type of system are flexibility, future expansion capability, rapid data reduction and reporting, compatibility with other processors (digital data can be transmitted directly to shore facilities without interference), and cost effectiveness. A shore-based computer center with a terminal at the platform was considered; however, because the incinerator operation and emergency shutdown are controlled by the computer, it would be safer to have the computer center on the platform.

5.2 MONITORING PLAN

The goal of monitoring the offshore incineration activities is to provide information needed for predicting, maintaining, and documenting conditions for the safe disposal of the waste materials and for the protection of personnel and the environment. To accomplish this the prototype monitoring plan includes several different components.

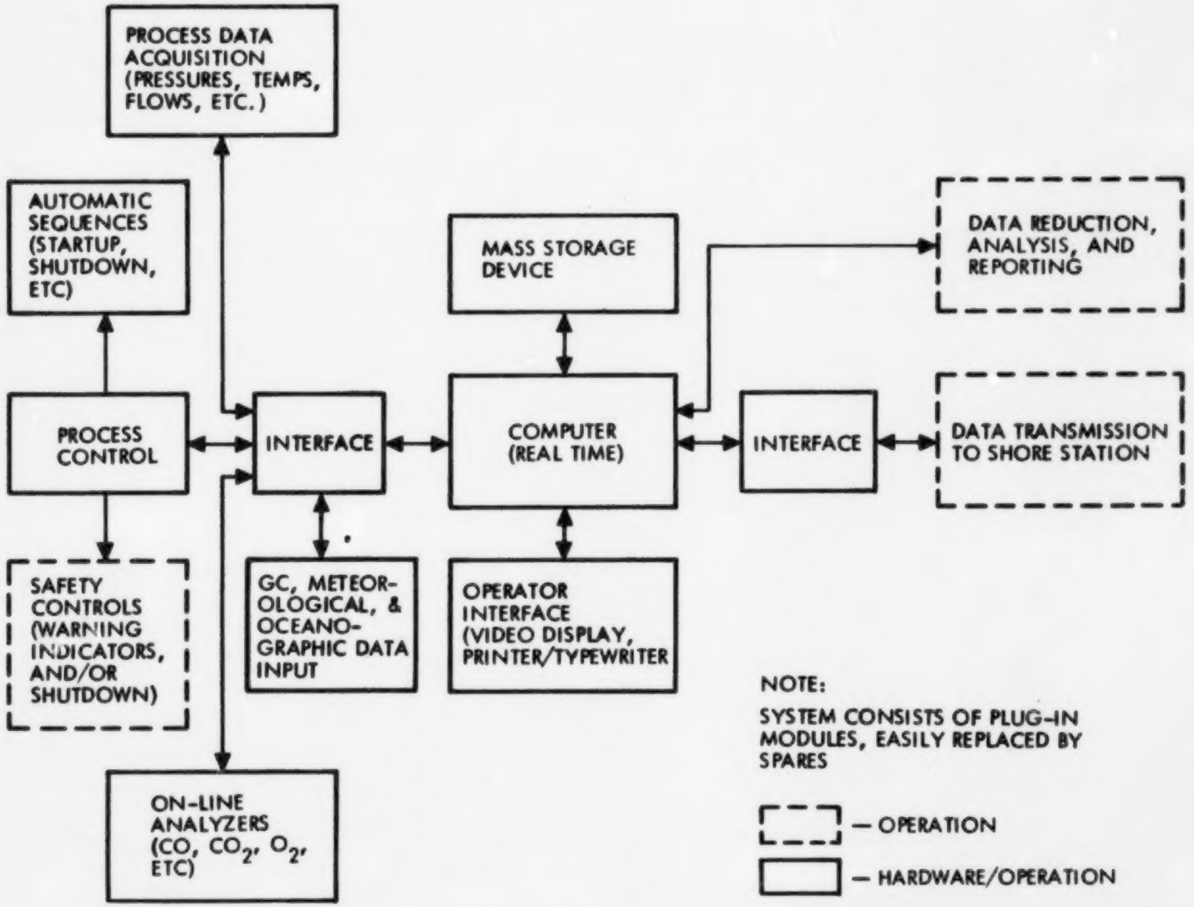
PROCESS DATA ACQUISITION (PRESSURES, TEMPS, FLOWS, ETC.)
AUTOMATIC SEQUENCES (STARTUP, SHUTDOWN, ETC)
PROCESS CONTROL
SAFETY CONTROLS (WARNING INDICATORS, AND/OR SHUTDOWN)
ON-LINE ANALYZERS (CO, CO2, O2, ETC)
INTERFACE
GC, METEOROLOGICAL, & OCEANOGRAPHIC DATA INPUT
MASS STORAGE DEVICE
COMPUTER (REAL TIME)
OPERATOR INTERFACE (VIDEO DISPLAY, PRINTER/TYPEWRITER
INTERFACE
DATA REDUCTION, ANALYSIS, AND REPORTING
DATA TRANSMISSION TO SHORE STATION
NOTE:
SYSTEM CONSISTS OF PLUG-IN MODULES, EASILY REPLACED BY SPARES
— OPERATION
— HARDWARE/OPERATION

Figure 4. Incinerator Control/Data Acquisition System Diagram

Monitoring will begin with the acquisition of a representative sample of the waste material at the waste generation or spill site. Analysis of this sample at the shore based support facility will determine handling and combustion requirements. During incineration, various indicators of combustion efficiency will be monitored by on-line gas analyzers and samples will be collected for laboratory analyses to determine waste destruction efficiency (see Figure 3 for sampling locations).

On-line gas analyzers and collected samples will also be used to monitor pollutants in the final air emissions, liquid effluents, and solid residue from the incineration system. The potential introduction of contaminants into the storage and work areas from fugitive and other inadvertant sources will be monitored. Because of the close proximity of the crew's living quarters to the waste storage and incineration areas, monitoring for the introduction of contaminants into the quarters will also be needed. For personnel safety, as well as for the protection of the platform structure itself, meteorological and oceanographic conditions (such as wind speed and direction) will be monitored to prevent undesirable exposure to toxic or corrosive emissions.

The foregoing monitoring activities require specialized equipment and facilities which will involve both the shore based support facility and the offshore platform. In general, the shore based facility will be equipped to perform the more sophisticated, detailed analyses on collected samples, while the offshore facility will perform on-line measurements and quick-response type analyses.

Because of the remoteness and isolation of the offshore facility, it is important that a generous supply of spare parts be stocked for each instrument or piece of equipment in the monitoring system. Spare sensors must be available for the meteorological and oceanographic systems. In addition complete spare instruments must be available for each on-line gas analyzer, the gas conditioners, and the gas chromatograph. Much of the need for being prepared for contingencies with the gas analyzers can be met by designing a manifold system that allows maximum flexibility.

A preliminary design of such a system is shown in Figure 5. With this system, a backup for each type of analyzer is already plumbed and each instrument can be in either the calibration, purge, or sample gas analysis mode independently of the other instruments. Every instrument can be used to analyze either combustion gas or stack gas, and a spare gas conditioner is available as well. Each gas conditioner can deliver either stack gas to the stack gas manifold or combustion gas to the combustion gas manifold through three-way valves (Figure 5).

Most of the data resulting from the monitoring activities will be handled by the platform facility's computer. As shown in Figure 6, direct measurements by monitoring instruments will be digitized for interfacing directly with the computer. Visual observations and data resulting from laboratory analyses will be entered manually. The computer will then store, reduce, and analyze the raw data. Outputs will include information needed by the platform facility operators, complete reports of raw or reduced data, and transmissions to the shore based support facility.

Details of each of the monitoring activities are discussed in the following order:

- Waste feed characterization
- Combustion efficiency determination
- Waste destruction efficiency determination
- Emission and effluent pollutant measurements
- Storage and work area contaminant measurements
- Meteorological and oceanographic measurements.

5.2.1 Waste Feed Characterization

A sample of the chemical waste to be incinerated will be taken when the waste is being loaded into containers for shipment to the temporary storage area at the shore based support facility or the offshore platform. It is crucial for this sample to be representative.

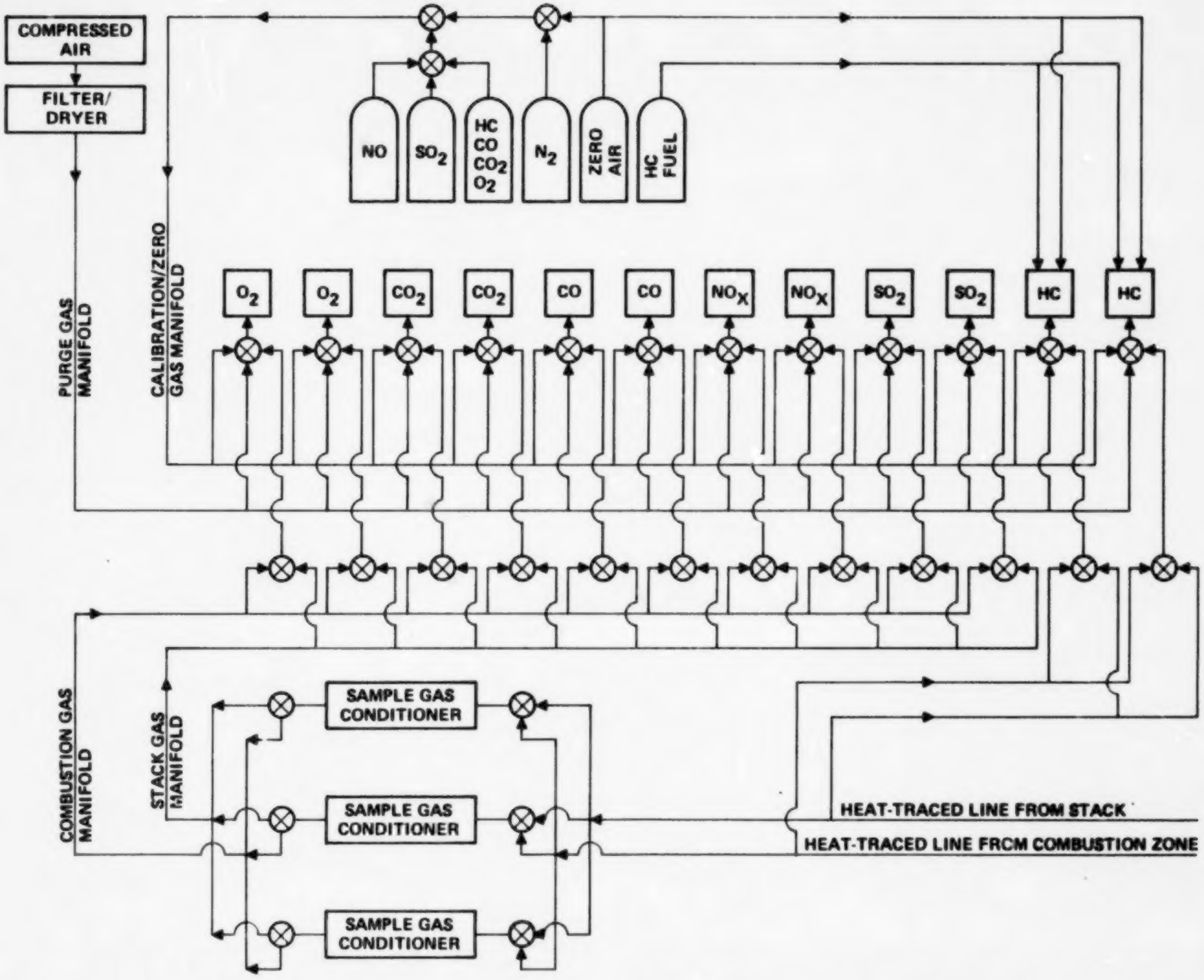
COMPRESSED AIR
FILTER/ DRYER
PURGE GAS MANIFOLD
CALIBRATION/ZERO GAS MANIFOLD
NO
SO_2
HC CO CO_2 O_2
N_2
ZERO AIR
HC FUEL
O_2
O_2
CO_2
CO_2
CO
CO
NO_X
NO_X
SO_2
SO_2
HC
HC
COMBUSTION GAS MANIFOLD
STACK GAS MANIFOLD
SAMPLE GAS CONDITIONER
SAMPLE GAS CONDITIONER
SAMPLE GAS CONDITIONER
HEAT-TRACED LINE FROM STACK
HEAT-TRACED LINE FRCM COMBUSTION ZONE

Figure 5. Preliminary Design of On-Line Gas Analyzer Manifold System

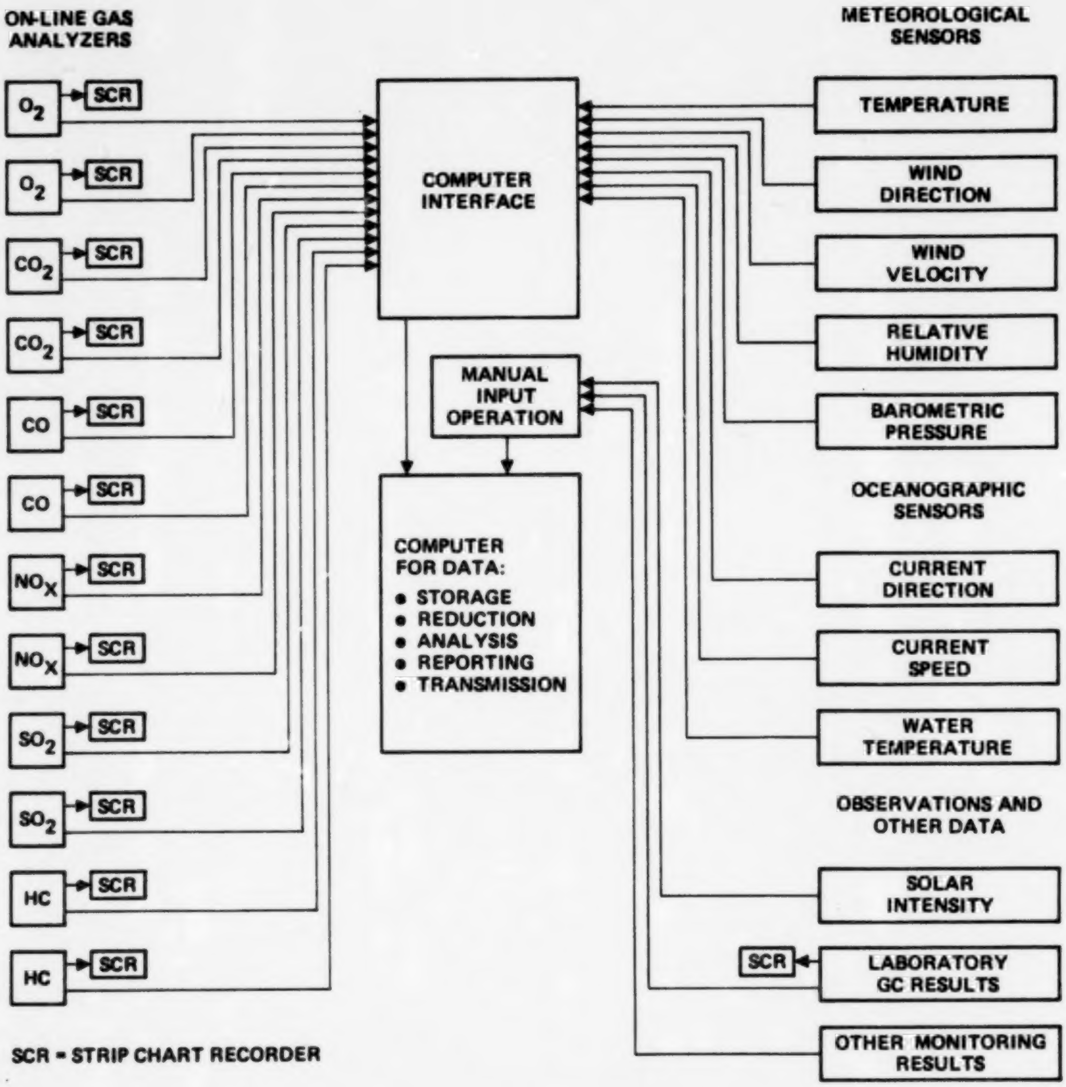
ON-LINE GAS ANALYZERS
O_2
SCR
O_2
SCR
CO_2
SCR
CO_2
SCR
CO
SCR
CO
SCR
NO_X
SCR
NO_X
SCR
SO_2
SCR
SO_2
SCR
HC
SCR
HC
SCR
SCR = STRIP CHART RECORDER
COMPUTER INTERFACE
MANUAL INPUT OPERATION
COMPUTER FOR DATA:
• STORAGE
• REDUCTION
• ANALYSIS
• REPORTING
• TRANSMISSION
METEOROLOGICAL SENSORS
TEMPERATURE
WIND DIRECTION
WIND VELOCITY
RELATIVE HUMIDITY
BAROMETRIC PRESSURE
OCEANOGRAPHIC SENSORS
CURRENT DIRECTION
CURRENT SPEED
WATER TEMPERATURE
OBSERVATIONS AND OTHER DATA
SOLAR INTENSITY
SCR
LABORATORY GC RESULTS
OTHER MONITORING RESULTS

Figure 6. Diagram of Monitoring System Data Handling

The representative waste sample will then be shipped to the shore based facility where it will be analyzed for several parameters as shown in Table 9.

TABLE 9. ANALYTICAL METHODS FOR REPRESENTATIVE WASTE SAMPLES

Parameter to Measured	Recommended Method	Potential Instrument Suppliers
Heating Value	Calorimetry	Parr
Viscosity	Viscosimeter	Precision Scientific Lab-Line
Percent Ash	Combustion and Gravimetry	Furnaces: Thermolyne Lindberg Balances: Cahn Sartorius Mettler
Gross Elemental Composition	Combination of Automated Techniques	Beckman Dohrmann Perkin-Elmer
Trace Metals	X-Ray Fluorescence	EG&G Ortec Kevex Philips Siemens
Organic Compounds	Gas Chromotography/ Mass Spectrometry	DuPont Finnigan Hewlett-Packard Varian

The information resulting from these analyses will supply answers to important questions that must be determined prior to incinerating the waste, such as:

- Will the waste support combustion?
- Will auxiliary fuel be needed?
- Can the waste be mixed safely with other wastes?
- Should the waste be fed as a solid or as a liquid?

- Will operation of the venturi scrubber be required?
- What compounds should subsequently be measured to determine waste destruction efficiency?
- What potentially hazardous waste components should be monitored and how (i.e., in the air emissions, liquid effluents, and solid wastes; and as contaminants of the personnel quarters)?

During the waste incineration, additional waste samples will be taken and analyzed onshore in order to confirm the presence and concentration of key species for the waste destruction determinations and other monitoring activities.

5.2.2 Combustion Efficiency Determination

The parameters that reflect combustion efficiency will be monitored at a point between the afterburner and the seawater quench. O_2 will be monitored because it is a critical parameter for tuning the combustion process to desired stoichiometric conditions. CO and total hydrocarbons (HC) will be monitored to provide immediate information regarding the completeness of combustion, and CO_2 will be monitored so that an average combustion efficiency can be calculated by the following equation:

$$\%\text{ Combustion Efficiency} = \frac{[\%CO_2] - [\%CO]}{[\%CO_2]} \times 100$$

The monitoring instruments and their strip chart recorders will be contained in the control room, where they will be easily visible to the incinerator operators. Instrument data will also be transmitted to the computer for storage and other operations.

5.2.3 Waste Destruction Efficiency Determination

Samples for the determination of waste destruction efficiency will be collected from a sampling port between the afterburner and quench sections with a train such as illustrated in Figure 7. The train

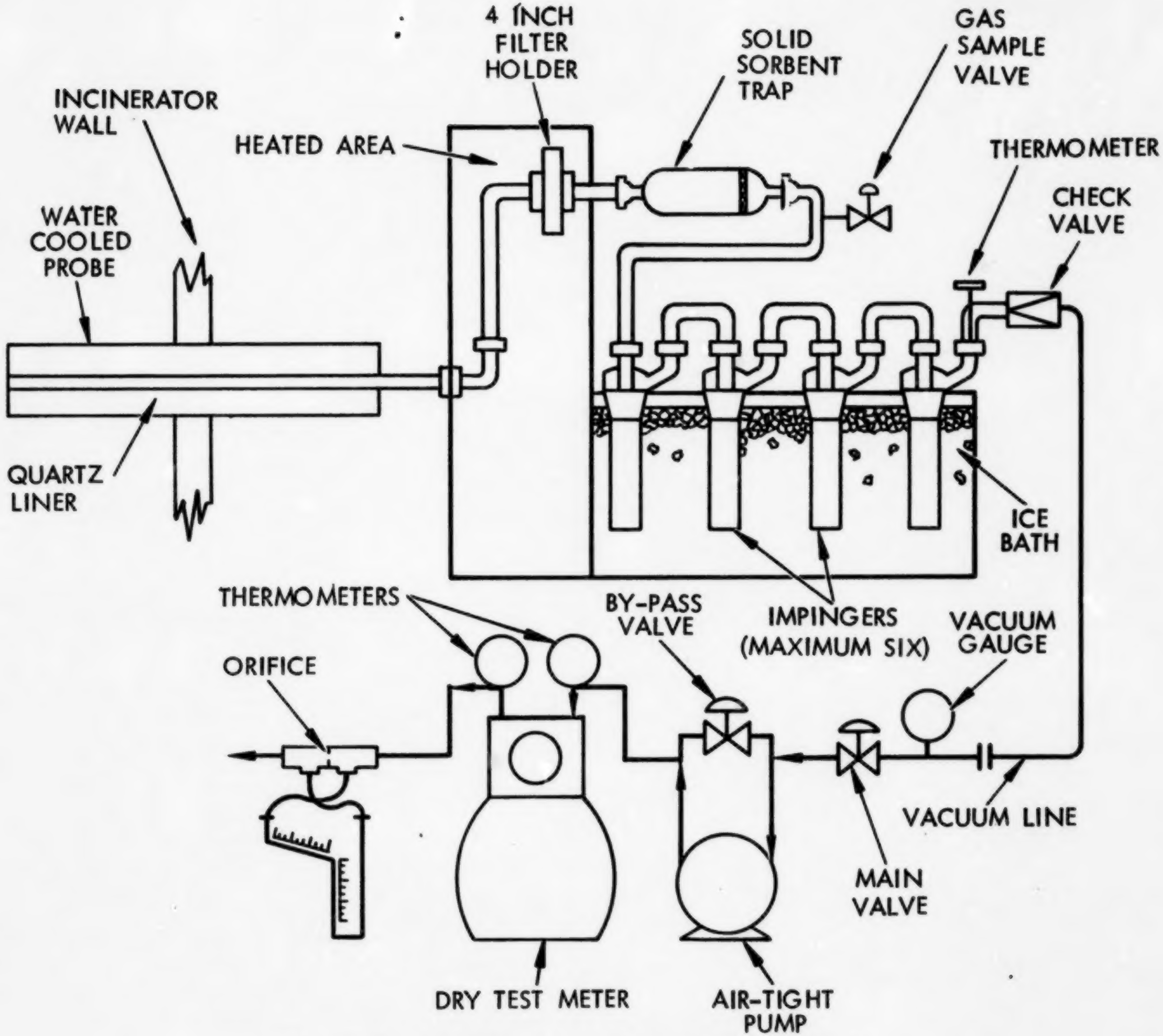
4 INCH FILTER HOLDER
SOLID SORBENT TRAP
GAS SAMPLE VALVE
INCINERATOR WALL
HEATED AREA
THERMOMETER
WATER COOLED PROBE
CHECK VALVE
QUARTZ LINER
ICE BATH
THERMOMETERS
BY-PASS VALVE
IMPINGERS (MAXIMUM SIX)
VACUUM GAUGE
ORIFICE
VACUUM LINE
MAIN VALVE
DRY TEST METER
AIR-TIGHT PUMP

Figure 7. Schematic of Typical Sampling Train

components will need to be flexibly applied and interchanged in order to meet the requirements of each waste being destroyed. Some exmaples are:

- For wastes in which the toxic compound is present only in trace amounts it might be recommended to replace the sorbent trap with solvent impingers for organics collection in order to obtain maximum sensitivity and detection limits.
- For halogenated wastes caustic impinger solutions will be needed to protect the meter and pump from acid corrosion.
- For fluorinated wastes a glass wool plug will be needed to scavenge the HF and protect the train's glassware.

Results from the waste feed characterization effort will be used to evaluate each waste to determine which components to monitor for destruction efficiency and how best to sample for them. Collected samples will then be extracted and analyzed by gas chromatography (GC) at the offshore laboratory. Verification of any compounds identified will be conducted using a gas chromatograph/mass spectrometer (GC/MS) at the shore based support facility. The calculation of waste destruction efficiency (DE_{waste}) is based upon comparing the waste input rate to the waste emitted rate by the following equation:

$$DE_{waste} = \frac{\text{waste input - waste emitted}}{\text{waste input}} \times 100\%$$

5.2.4 Emission and Effluent Pollutant Measurements

The offshore incineration system will have air emissions, liquid effluents, and solid wastes. Monitoring needs for each pollutant are discussed separately in the following sections.

5.2.4.1 Air Emissions

There will be two methods for monitoring emissions from the stack. Criteria pollutants such as CO, SO_x, NO_x, and total hydrocarbons will be continuously monitored by on-line instrumentation. The stack emissions will be routinely monitored; however, the optional sampling point at the entrance to the seawater venturi scrubber can also be monitored to determine the efficacy of the scrubber for removing these pollutants.

The second monitoring method will be to collect particulate and organic pollutants using a sampling train such as illustrated in Figure 7. Measurement of total particulates and a qualitative look at any organics will be performed at the offshore laboratory. If significant organics are found, more detailed analyses using GC/MS will be conducted at the shore based facility laboratory.

5.2.4.2 Liquid Effluents

Samples of seawater quench effluent and venturi scrubber effluent (when operating) will be collected. The input seawater will also be sampled for background measurements. Specific organic compounds and/or inorganic elements to be measured will be selected for each waste based on the waste's composition. Some tests can be performed at the offshore laboratory, but most will be quite labor intensive due to the severe interferences and background problems caused by the complex seawater matrix. These analyses are more suitable for the shore based facility.

5.2.4.3 Solid Wastes

Solid residues from the rotary kiln will be analyzed prior to their final disposal (Section 5.3.3). Samples collected from the bottom ash hopper will be tested for specific organic compounds based on the waste's composition. The extractions and GC analysis can be performed in the offshore laboratory and routine checks to verify the GC results will be performed using the shore based laboratory's GC/MS.

5.2.5 Storage and Work Area Contaminant Measurements

There are two potential sources for introducing contaminants to the storage and work areas (including the living areas on the platform). One is from airborne contaminants (i.e. the incinerator plume, should it fail to disperse or actually touch down on the platform, or fugitive emissions from handling and transfer operations) and the other is transport of waste materials on the surfaces of shoes, clothes, skin, and equipment. Contaminants from both of these sources will be monitored.

The ambient air quality at the onshore facility and on the platform will be checked at regular intervals or as needed if there are unusual weather conditions. These checks will be performed with calibrated indicating tubes. There are several manufacturers of comparable tubes including Drager, Bendix, and Matheson.

Numerous compound specific tubes are available. However, the monitoring needs would be met by using a general array of tubes that cover the compounds or types of compounds that are of interest. The following tubes are recommended: Cl_2, HCl, SO_2, NO, NO_2, CO, benzene, and hexane. A log of the results will be kept and entered into the computer.

The inadvertent transport of waste materials will be checked by taking wipes of:

- Paricularly suspect surfaces (i.e., doorknobs, handrails, workbenches, etc)
- Other randomly selected areas in the living quarters, storage areas, and work areas.

These wipes will be solvent extracted and analyzed by gas chromatography in the offshore facility laboratory. If positive results are obtained, the affected area must immediately be cleaned until negative wipe test results are obtained.

Whenever particularly hazardous materials (e.g., containing PCBs, TCDD, POMs, heavy metals, etc.) are being handled, special monitoring should be performed. This could take the form of more frequent indicator tube and wipe checks and/or specific measurements (e.g., Chomosorb 102 tubes to collect fugitive organic vapors) for specific waste components. The type of special monitoring needed will have to be evaluated and specified on a case-by-case basis, taking into consideration the hazardous components of the waste involved. The special monitoring activities may require support from the shore base facility to verify and confirm tests for specific elements or compounds.

5.2.6 Meteorological and Oceanographic Measurements

Because of concern regarding the behavior of the stack plume and the effluent from the seawater quench and scrubber systems, it will be necessary to monitor certain meteorological and oceanographic parameters. The resulting data will be used to:

- Indicate unfavorable conditions during which waste destruction must be curtailed
- Calculate or model the dispersion of pollutants
- Document conditions during periods of waste destruction activities

Systems are available that combine the meteorological and oceanographic measurements into one package and also provide output suitable for interfacing with the computer. The following sensors will be needed for the offshore platform system.

Meteorological	Oceanographic
Wind speed	Current speed
Wind direction	Current direction
Temperature	Temperature
Relative humidity	
Barometric pressure	

Solar radiation sensors are also available to provide the measurement of solar intensity which is needed for plume dispersion models. However, only a qualitative number is needed, and it is planned that platform personnel can provide satisfactory visual observations of solar intensity.

5.3 SYSTEMS OPERATION PLAN

The objective of the systems operation plan is to identify and plan in logical sequence all activities necessary in the operation of the offshore incineration platform for destruction of hazardous waste. The plan is developed in terms of the sequential flow of activities and decision points dictated by the incineration process requirements and by constranints imposed for safety and environmental protection.

Four sequential operations take place in any waste disposal action:

- Waste collection and preparation
- Waste transporation
- Waste disposal
- Waste container/equipment decontamination.

In the waste collection and preparation steps, all actions are initiated to develop a safe and reliable disposal. The information needed to do this is obtained by an initial general identification of the waste and circumstances surrounding the waste disposal action, and from actual anlaysis of waste samples. This information dictates actions necessary to comply with existing regulations on incident reports and transportation, records, etc., as well as to determine safe containers, incineration conditions, and handling.

In the waste transportation steps, the logistics of actual movement of waste, usually first to an incinerator staging area then to the platform itself, are identified.

In the waste disposal steps, the delivery of the waste from its container to the incinerator, processing of the waste in the incinerator, and monitoring/operation conditions associated with the waste disposal are covered. Disposal of any solid waste resulting from the incineration or associated precedures is also covered in this sequence.

In the final step, which may occur only at intervals, the incineration equipment and salvageable waste containers are decontaminated sufficiently for renewal of the cycle. In the case of equipment, this covers procedures to be followed prior to shutdown, repair maintenance, or change to a different waste or incineration condition. In the case of salvageable waste containers, this includes any treatment prior to return to the staging area for reuse.

The operational sequence is shown in the flow diagrams, Figures 8 through 11. The systems operation plan is discussed in terms of this operational sequence in the following paragraphs. Estimated personnel requirements for system operation are also described.

5.3.1 Waste Collection and Preparation

Immediately on notification of waste availability for incineration, an evaluation will be made pursuant to the National Oil and Hazardous Substance Dillution Contingency Plan, 40 CFR 1510, concerning spills, incidents, etc. Following authorization, plans for shipment and for developing acceptable incineration conditions will be initiated, and the D.O.T. hazardous material manifest will be prepared and submitted. An on-site visit will be made by technical personnel, at which time representative samples of the waste will be obtained (Section 5.2.1). The results of this sampling will provide the experimental evidence needed to determine incinerator conditions (waste feed rate, use of auxiliary fuel), types of monitoring equipment required (Section 5.2.4), and any special safety precautions or decontamination procedures that may be required in the subsequent handling of the waste.

A definitized handling sequence plan will be generated using the D.O.T. and spill regulations, the location and physical conditions of the in situ waste, generic waste information, and specific chemical analyses. The corrosiveness, volatility, flammability, and general toxicity will be used to determine if special containers for waste transfer are required. Similarly, any exposure/handling precautions will be identified. A determination will be made of the extent required for the clean up (for example, a liquid pool plus the contaminated sand to a depth of x feet) since this will affect the nature of the waste being transported. Incineration provisions must be made for possible variations in physical conditions expected during the cleanup, i.e., variations in water content, sand, debris, tar, etc.

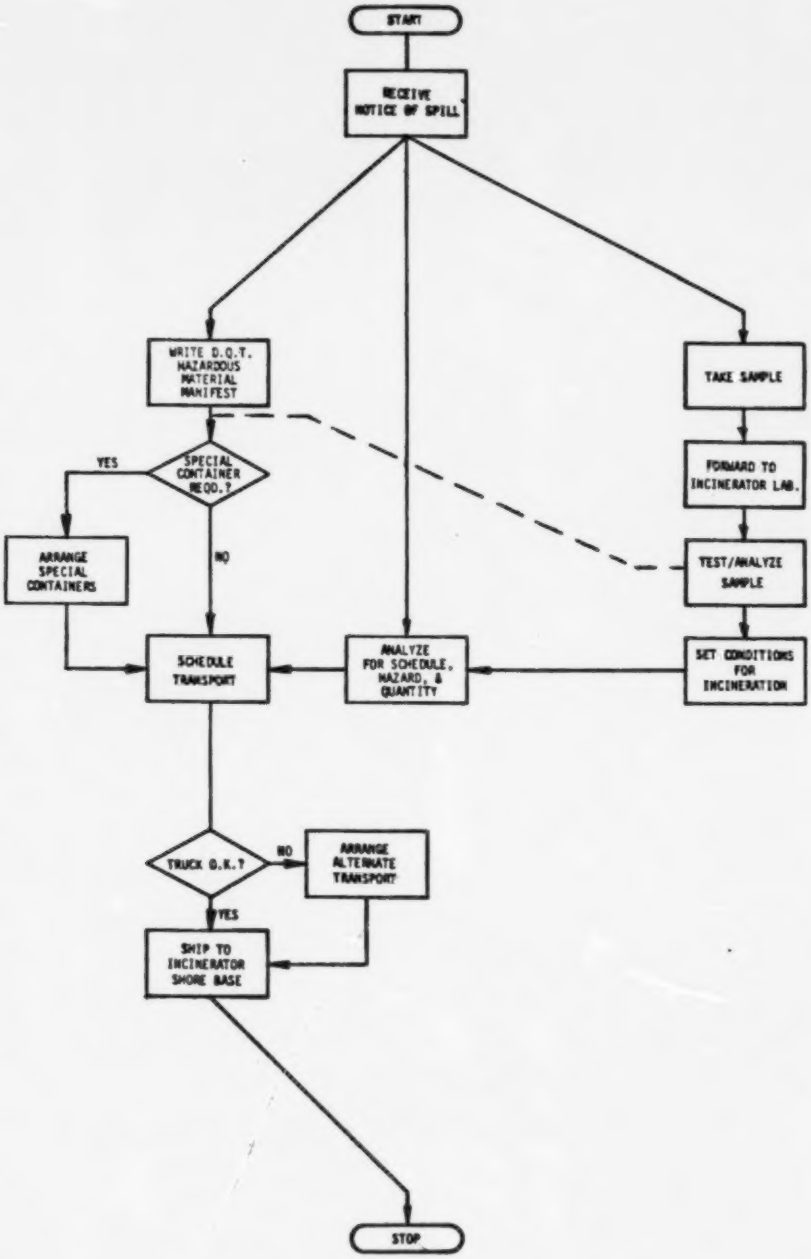
START
RECEIVE NOTICE OF SPILL
WRITE D.O.T. HAZARDOUS MATERIAL MANIFEST
SPECIAL CONTAINER REQD.?
YES
NO
ARRANGE SPECIAL CONTAINERS
SCHEDULE TRANSPORT
ANALYZE FOR SCHEDULE, HAZARD, & QUANTITY
TAKE SAMPLE
FORWARD TO INCINERATOR LAB.
TEST/ANALYZE SAMPLE
SET CONDITIONS FOR INCINERATION
TRUCK O.K.?
NO
YES
ARRANGE ALTERNATE TRANSPORT
SHIP TO INCINERATOR SHORE BASE
STOP

Figure 8. Flow Diagram: Spill Cleanup Process

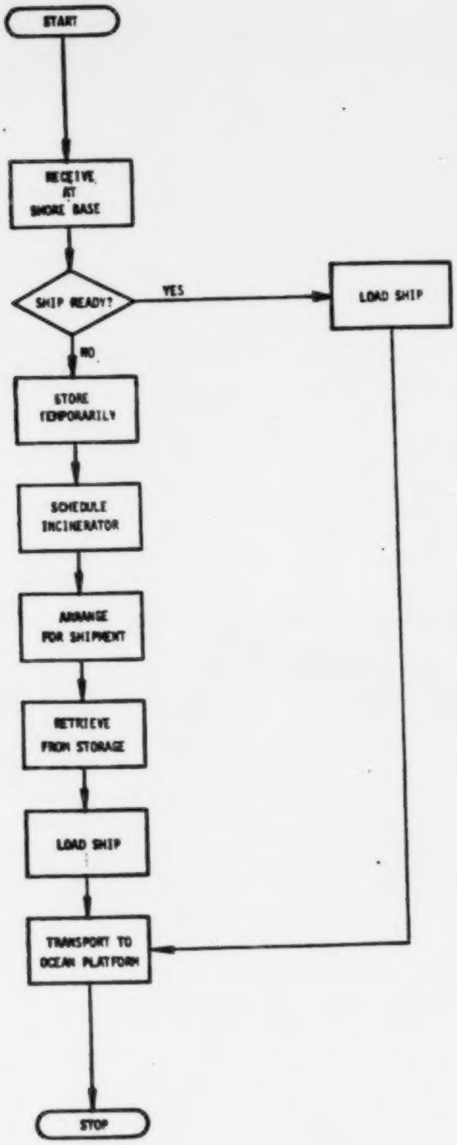
START
RECEIVE AT SHORE BASE
SHIP READY?
YES
LOAD SHIP
NO
STORE TEMPORARILY
SCHEDULE INCINERATOR
ARRANGE FOR SHIPMENT
RETRIEVE FROM STORAGE
LOAD SHIP
TRANSPORT TO OCEAN PLATFORM
STOP

Figure 9. Flow Diagram: Waste Shipment to Platform

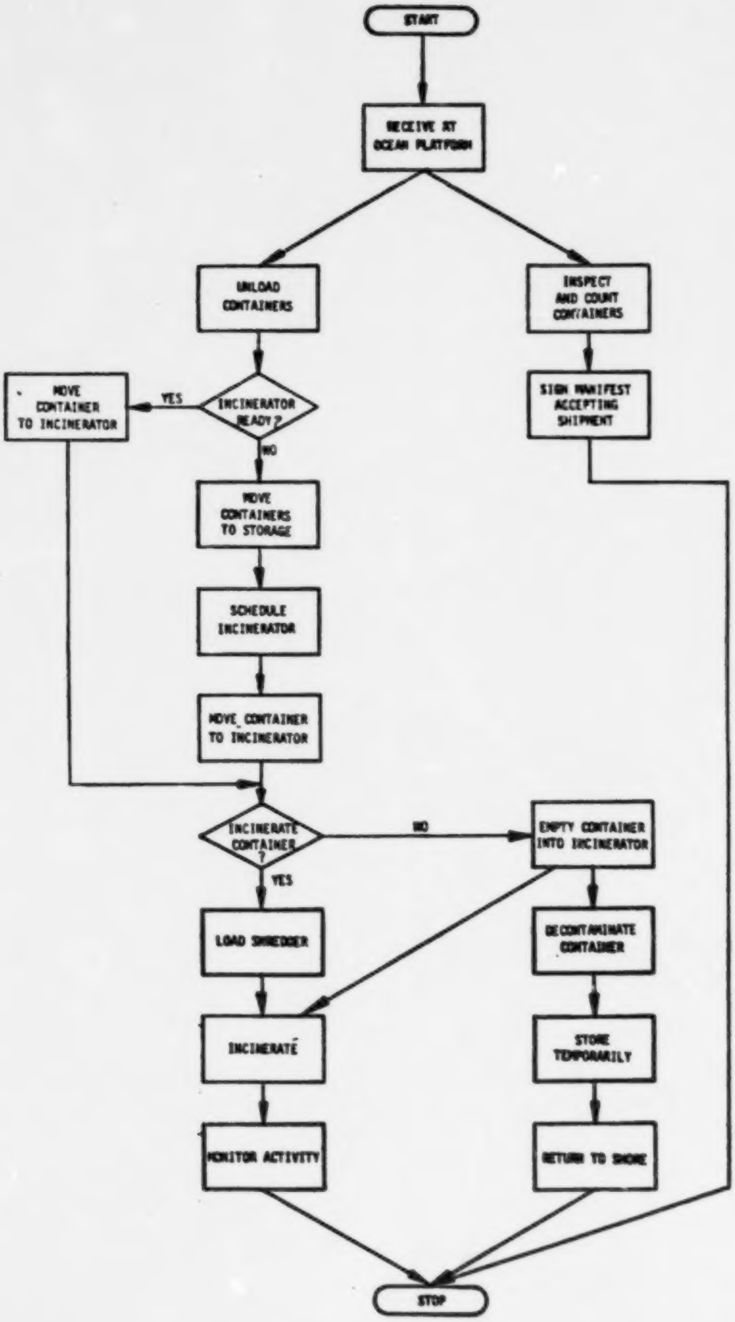
START
RECEIVE AT OCEAN PLATFORM
UNLOAD CONTAINERS
INSPECT AND COUNT CONTAINERS
MOVE CONTAINER TO INCINERATOR
YES
INCINERATOR READY ?
NO
SIGN MANIFEST ACCEPTING SHIPMENT
MOVE CONTAINERS TO STORAGE
SCHEDULE INCINERATOR
MOVE CONTAINER TO INCINERATOR
INCINERATE CONTAINER ?
NO
EMPTY CONTAINER INTO INCINERATOR
YES
LOAD SHREDDER
DECONTAMINATE CONTAINER
INCINERATE
STORE TEMPORARILY
MONITOR ACTIVITY
RETURN TO SHORE
STOP

Figure 10. Flow Diagram: Incineration Ocean Platform

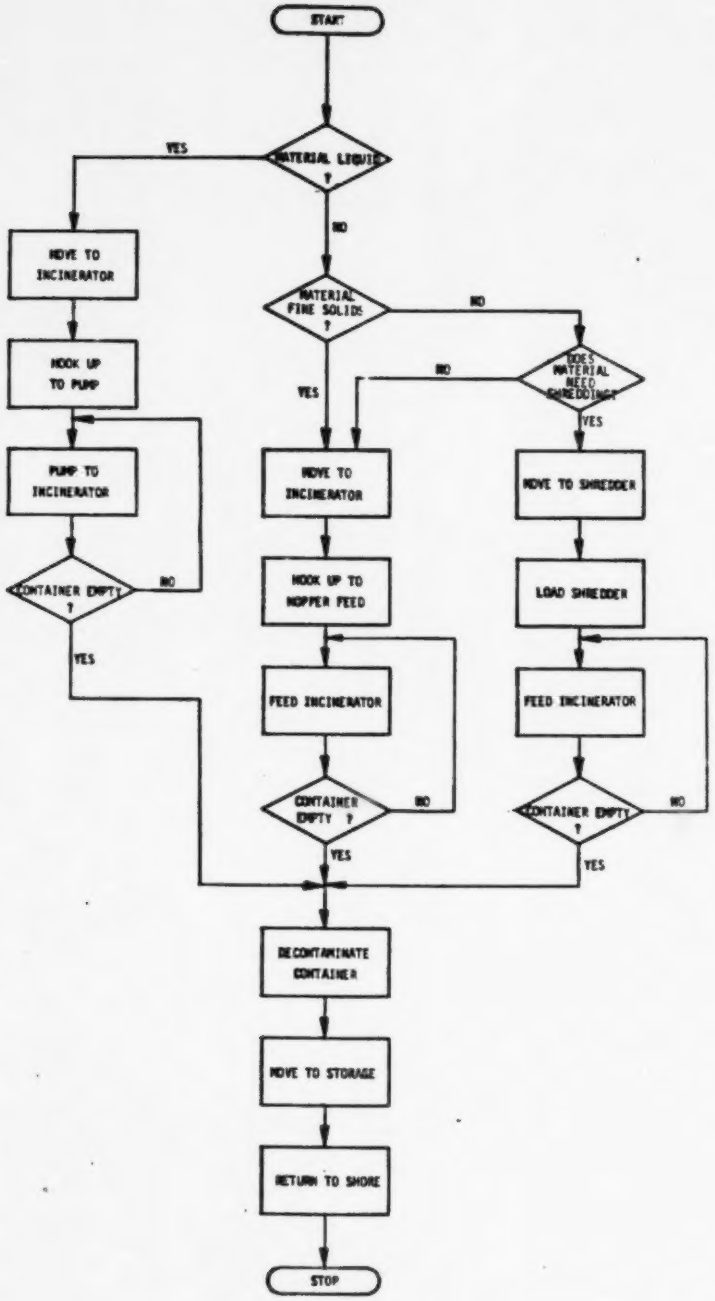
START
MATERIAL LIQUID ?
YES
NO
MOVE TO INCINERATOR
HOOK UP TO PUMP
PUMP TO INCINERATOR
CONTAINER EMPTY ?
NO
YES
MATERIAL FINE SOLIDS ?
NO
YES
DOES MATERIAL NEED SHREDDING?
NO
YES
MOVE TO INCINERATOR
HOOK UP TO HOPPER FEED
FEED INCINERATOR
CONTAINER EMPTY ?
NO
YES
MOVE TO SHREDDER
LOAD SHREDDER
FEED INCINERATOR
CONTAINER EMPTY ?
NO
YES
DECONTAMINATE CONTAINER
MOVE TO STORAGE
RETURN TO SHORE
STOP

Figure 11. Flow Diagram: Detail - Incineration

An inspection will be made of all containers prior to loading with the waste. This inspection will verify that the approved type of containers are being used, that integrity requirements (absence of damaged threads and dents) are met, and that proper seals, identity labels, and materials for contingency of spillage during loading are available.

The actual waste loading will be followed by an inspection for absence of leaks and external contamination. Equipment used for transferring the waste to the containers will be packaged for decontamination at the end of the operation.

Firm commitments for transfer of the approved waste containers will be obtained. This commitment will include methods of transport, schedules, waste code identifications, routes, destinations, and authority transfer requirements. Written instructions will be provided for actions in case of spillage, fire, or need for in-transit transfer from one vehicle to another.

It is necessary to determine, prior to shipment, whether or not the waste must be transferred through a shore based staging area prior to delivery to the platform. This determination will be made on the basis of factors such as available storage space on the platform, incineration schedule, and nature of the waste.

5.3.2 Waste Transportation

The waste transportation activities include actual movements and temporary storages of the waste prior to delivery to the platform. It will be necessary to maintain records providing traceability of each waste storage and movement, including dates, type of transportation, storage location and type of storage, responsible individual, waste receipt inspections, damage, repairs, and sampling or other incidents affecting the integrity of the waste containers. Waste "travelers" will be used to maintain this information physically present with the waste at all times. The traveler will also identify requirements which must be met in order for the waste to proceed along its transportation route. These requirements include temporary storage time limits at shore base, container integrity inspections, accountability of waste quantity, and in some instances specific storage or handling precautions. Failure to meet these requirements will be reported immediately to the shore based designated transportation-responsible person who will determine disposition.

Shipment arrangements will be scheduled in conjunction with platform incineration schedules. After an initial transient condition in which shore based storage is developed to a selected logistic level, transportation flow will be arranged so that the movement is dictated by the incineration scheduling, i.e., backlogs aboard platforms are to be strictly controlled. A minimum of three waste container inspections will be required during the transportation phase; one, at the waste generation site, a second at the shore-based facility, and the third at the platform storage area. These inspections will provide evidence of container accountability and integrity. A final container accountability will be required during the waste container/equipment decontamination processes (Section 5.3.4).

5.3.3 Waste Disposal

The disposal steps for the waste on the platform are primarily dependent on the interaction between the feed system to the incinerator and the physical nature of the waste (solid, slurry or liquid).

Liquid wastes require the least complex feed system. Consequently, the incineration conditions, auxiliary fuel requirement if necessary, feed rates, etc., will be established primarily from data supplied by the shore-based analyses (Section 5.3.1). Log books will be kept during the entire process from transfer from container to scrubber operation (if required). This log book will document the transfer equipment used, pumping times, pumping rates, sample locations and frequency, temperatures and pressures of fluids, exhausts, scrubber conditions, transfer times for each container, container temporary disposition, visual plume condition, etc. Information required for interpretation of on-line gas analyzers or samples collected for destruction efficiency determination (feed rates, waste composition, sample collection times, flow rates, etc., Sections 5.2.2, 5.2.3, and 5.2.4) will be entered into the computerized monitor system. The monitoring plan for incinerator operation is disucssed further in Section 5.2, including incinerator and safety monitoring considerations.

Slurry or multiphase liquid wastes require more complex feed systems. It will be necessary to account for the inhomogeneity of the waste by intorducing a mixing step such as a venturi section prior to injection into the incinerator. Also, flow rate measurements must be examined in terms of the waste properties. Following injection into the incinerator, the plan will proceed as described for liquids.

Solid or solid/liquid mixtures which cannot be handled directly as liquids present the most difficult case. Based on previous inspection of the material, a decision will be made whether or not to pass the waste through a shredder for size reduction before loading the incinerator. This shredder operation will be enclosed and capable of transfer of shredded waste directly into the incinerator by means of a screwdrive. Fumes from the shredder will be ducted into the kiln. Because of variability expected in the shredded waste, incinerator conditions must be coupled with feed screw rate and on-line monitor results. This computerized input will be used to insure that design safety requirements for pollution emissions are met. Auxiliary fuel will be used as required, including waste contaminated rinse liquids from container/equipment cleanup (Section 5.3.4).

It is anticipated that a portion of the waste containers will be shredded and incinerated, particularly certain plastic containers or metal containers sufficiently damaged so that they cannot be reused or decontaminated and sold as metal scrap. Of the three incineration feed modes, the shredded solid mode will present the largest ash disposal load. The ash will be collected (possibly in decontaminated waste containers) while shore-based analyses of ash samples progress. If the ash is found free (below a given level) of the substances used for the destruction efficiency calculation, the ash will be disposed of as solid waste. Depending on the nature of the ash, as determined by analysis, preferential disposal will be at sea, using quench and scrubber flows to disperse the solids. For solid wastes containing unacceptably high concentrations of toxic trace elements or soluble salts, the waste will be repackaged onboard the platform and returned to the shore base for storage and disposal by other methods. Handling of such wastes will be done with the same precautions and documentation as the incoming wastes. Ash found to be contaminated with the hazardous waste will be recycled into the incinerator to remove the contamination in the second firing.

5.3.4 Waste Container/Equipment Decontamination

The platform waste disposal facility will have provisions to decontaminate reusable containers for recycling purposes. It is inadvisable to reuse empty but not decontaminated containers which are being recycled for the same waste because of the continued container accountability and handling procedures. Instead all returned containers will be completely decontaminated before leaving the platform. As part of the waste study developed from the analysis of the original waste, a decontamination procedure will be identified for offshore use. This procedure will be applied to all returned containers for a specific waste. Further, a coding will be marked on the container indicating the waste and date of decontamination.

The decontamination procedure will generally consist of agitation and flushing with a combustible liquid such as diesel oil. This waste oil will be used as auxiliary fuel for the incinerator. In instances where solids or incompatible liquids are present, detergents, emulsifying agents and mixed solvents will be available as indicated by the waste disposal study performed on the original waste. The acceptability of the decontamination procedures used will be established by comparing solvent wash or wipe specimen analyses to specified pollutant concentration limits. Water or water/detergent rinses may be required in some instances to comply with decontamination requirements. All such rinses will be disposed of by injection into the incinerator. All containers which cannot be decontaminated economically will be shredded and fed into the incinerator.

The decision to dispose of damaged containers as metal scrap will be based on the type of waste, the extent of contamination remaining in the container, and the difficulty in providing control precedures to ensure no pollution is introduced into the land environment as part of the scrapping procedure. If the crushed containers are sold to a steel mill, for example, a sealed transport container will be routed directly to the steel mill, and steel mill handling procedures will be specified and controlled.

Equipment decontamination procedures will also be available. Two kinds of decontamination will be available, one for use between wastes of sufficiently different characteristics that some hazard may exist if they are mixed (for example, shredding aluminum containers in the presence of certain chlorinated hydrocarbons is inadvisable), and the second for use when equipment must be dismantled for inspection, maintence, or repair. Generally, interaction between wastes will be prevented by flushing the equipment with an innocuous material. In the shredder, for example, paper or wood products may be used. In liquid systems diesel oil will be the probable choice. In general, the decontamination will be complete when the reactive material is sufficiently diluted to prevent explosion, hot spots or excessive pressure in subsequent operation of the equipment.

Equipment decontamination prior to personnel access and other personnel protection measures will be ensured by detailed training sessions for operators, by clearly visible instructions and safety rules for referral at any time, and by frequent safety inspections by a monitor appointed from among the platform personnel. For equipment the general guideline for completeness of decontamination will be that properly protected personnel may safely work on the equipment for the necessary exposure period, and that transient pollutant emissions during this period will not exceed designated environmental limits. For personnel, the following protective measures will be provided:

- An outer disposable protective garment will be provided for single usage and subsequent incineration.

- Clothing immeditately adjacent to the outer garment will be laundered before reuse.
- A decontamination facility will be provided for removal and isolation of contaminated clothing.
- Emergency showers will be placed at strategic positions.
- Platform air and wipe tests of living areas and intermediate work areas (Section 5.2.5) will be analyzed to verify acceptable quality.
- Medical examinations will be required for all platform workers initially and at interfals thereafter. The interval will be adjusted in accordance with the waste being processed.
- Isolation and protection measures for transients and visitors will be provided in terms of clothing, limited access areas, and decontamination facilities.
- Labeled covered receptacles for contaminated items will be provided at strategic locations with decontamination or disposal instructions clearly visible. Wipes and miscellaneous liquid wastes generated in decontamination will be injected into the kiln.
- Each equipment repair or spillage incident requiring decontamination will be recorded in the daily log. The log will identify the waste, the date, the decontamination action, and test results verifying decontamination.

5.3.5 Estimated Personnel Requirements

Estimated personnel required to operate the offshore incineration facility on a one-shift basis are listed below, along with their respective duties:

1	General Surpervisor:	Overall responsibility for facility operation, safety and personnel
2	Incinerator Operators:	Control incinerator feed and operation, monitor controls, and operate scrubber as required
1	Crane Operator:	1) Unload containers of materials for incineration 2) Assist incinerator operators as required

2	Maintenance Mechanics:	1) Perform maintenance as required, including machining welding, pipefitting, etc. 2) Assist in unloading material as required
1	Sampling and Analysis Team Leader:	1) Determine methodology 2) Direct sampling and laboratory personnel.
1	Laboratory Technician:	1) Perform required sample preparation and snslysis; 2) Monitor on-line emission instruments during sampling tests
1	Sampling Technician:	Set up sampling system and collect samples
1	Asst. Sampling Technician:	Assist in setting up sampling systems and collecting samples
1	Cook:	1) Prepare meals for platform personnel and guests 2) Order and monitor supplies
1	Steward:	1) Assist in meal preparation 2) Perform janitorial duties
12	Total	

Additional personnel will be required for emergency 24-hour/day operation (two 12-hour shifts). Berthing and mess facilties should be sized for emergency operation needs and to accommodate 2-3 visitors.

5.4 COST ANALYSIS

Estimates of the installed cost of the offshore incineration system and typical operational cost factors are presented in this section.

5.4.1 Equipment and Installation Costs

Cost estimates for the incineration system are based upon list prices of commercially abailable equipment which comprise the major components of the system. These prices were obtained from manufactures' lists and were effective during October 1979. Installation costs of the system are estimated to a rough order of magnitude because of uncertainties in labor costs and potential delays inherent in offshore operations.

Estimated costs of the offshore incineration system components and installation are:

A.	Combustion Engineering, Inc., "Tumble Burner," Model #12, including rotary kiln, refractory, feeder, afterburner, and scrubber	$ 670,000
B.	Saturn Manufacturing, Inc., Model 62-32 shredder, including electric motors and hydraulic drive unit	$ 64,000
C.	Monitoring Instrumentation, including gas conditioners, gas analyzers, recorders, sampling equipment, and meteorological and oceanographic instrumentation	$ 125,000
D.	PDP-1134A Digital Computer System, including data storage unit, typewriter, video display, high speed printer, and software	$ 120,000
E.	Installation of above components, including transportation erection, wiring, plumbing, auxiliary equipment such as exhaust stack, quench and scrubber water discharge piping, etc. Note: Not included are support buildings, basic foundation, utilities, fuel tanks, and crane for erection (all included in support facilities estimates)	$1,500,000
Total estimated cost		$2,479,000

Costs estimated for the offshore facility buildings, mechanical and electrical systems, and crane are described in detail in Section 6.5.2. In summary, these costs are:

A. Buildings	Living quarters, control center, helipad	$ 727,300
B. Subsystems	Mechanical and electrical	636,500
C. Crane	Boom type, 10 ton capacity	460,000
Total estimated cost		$1,823,800

5.4.2 Operational Costs

Operational costs for the offshore incineration facility as discussed in this section include labor, subsistence, fuel, maintenance, depreciation of equipment, and insurance. A government owned, contractor operated offshore incineration facility is assumed.

Labor cost estimates are based upon rates and working schedules prevalent for offshore oil platform workers. The present average wage for offshore platform personnel is $17-18 an hour, or approximately $40,000 a year for a 10 day on/10 day off schedule, 12 hours/day; this is a standard schedule for plaftorm workers. Therefore, labor costs for operating a 12-hour shift, 7 days per week, are approximately $80,000 yearly per crew assignment. Operation of the incineration platform for 24 hours/day would require two complete crews, except for supervisors who would normally be on duty for one shift but would be onboard for emergencies. Expenses for food and personnel related supplies are estimated at $12/day/person, based upon offshore oil platform cost information.

Diesel oil would be used onboard the ocean incineration platform for power generation and as auxiliary fuel for incineration of wastes with insufficient heat content. There is a possibility of utilizing gas and/or oil from reserves at the platform site for these purposes; however, existing wells are plugged and contain H_2S, therefore the use of diesel oil was assumed.

Major consumption of diesel oil would be as auxiliary fuel, estimated as an average of 50 percent of the nominal incinerator liquid feed rate of 300 gallons/hr, or 150 gallons/hr of diesel oil. Therefore, 3600 gallons of diesel fuel could be consumed during a 24-hour day of maximum rate incineration. Except for emergency periods, only one shift operation is intended with overnight maintenance of minimum temperatures to prevent cooldown of the incinerator brick lining. Therefore, 2000 gallons/day is assumed for a yearly consumption of 730,000 gallons of diesel oil as auxiliary fuel. High heat content wastes could be utilized in some cases to reduce auxiliary fuel requirements.

Additional uses of diesel fuel are for electric power generation, crane operation, and waste container rinsing (incinerated as auxiliary fuel). Estimated consumption for these purposes is 3000 gallons/week or 100,000 gallons/year. Cost of diesel oil is estimated at $.90/gallon.

Transportation of wastes, fuel, and supplies to the offshore platform incineration facility is assumed to be by workboats of the type used to supply oil drilling platforms. A typical 165 foot workboat will carry 48,000 gallons of fuel oil and 560 metric tons of deck cargo. Typical rates are $2000 to $2700 per day plus fuel costs of approximately $1500 per day for a boat leased for 6 months or longer. "Spot rates" for boat leasing every two weeks would be higher, and are assumed to be $6000 per trip to the platform. Helicopter service was estimated to be $1000 per week.

A yearly maintenance cost factor of 12 percent of the installed equipment cost is assumed. Straight line depreciation of equipment over a 5 year period results in a 20 percent per year depreciation cost. Buildings are depreciated over 10 years, or 10 percent per year.

In summary, the estimated yearly operational costs for 12 hours/day, 7 days/week operation of the offshore incineration facility, except for insurance costs, are:

A.	Labor	24 x $40,000/yr 12 person crew, 12 hrs/day 10 days on/10 days off	$ 960,000
B.	Subsistence	12 persons x $12/day x 365 days	$ 53,000
C.	Fuel	890,000 gallons x $.90/gal 730,000 gallons as auxiliary fuel, 160,000 gallons for power generation	$ 801,000
D.	Transportation	26 biweekly boat trips at $6000 each	$ 156,000
		Helicopter service at $1000/week	$ 52,000
E.	Maintenance	12% of installed equipment costs	$ 429,100
F.	Depreciation	20% of installed equipment costs	$ 715,100
		10% of building costs	$ 72,700
Total yearly operating costs (without insurance cost)			$3,238,900

Insurance cost is considered separately for two reasons: first, if the federal government owns the facility and assumes liability, no insurance cost is involved; second, if a contractor operating the facility must obtain insurance, the cost will vary greatly and may exceed all other operating costs combined. Insurance cost for a contractor will depend upon many factors not known at this time, e.g., type and amount of wastes, distances and routes transported, and what insurance coverage is presently carried by the contractor. In a paper presented at a recent Chemical Manufacturers Association seminar on hazardous waste, consultant Donald L. Henry stated that liability insurance coverage ($50 million per incident) for an at-sea incineration enterprise can be obtained for annual premiums on the order of $3 to $6 million.

Operational costs would be increased by approximately $2 million per year for 24 hour/day incineration with two complete crews, which would double the labor, subsistence, fuel and transportation costs. Insurance cost, if applicable, would also increase because of the larger volume of wastes incinerated and transported.

Costs of research burns would not be significantly higher, percentage-wise, compared to operational burns. Additional sampling, if required for research burns, could most likely be performed by the platform crew without extra manpower requirements. The cost of added analyses of research burn samples would not be an appreciable factor in the overall operational costs of the offshore incineration facility.

6. SUPPORT FACILITIES

This section describes the development of offshore and onshore facilities requirements, the conceptual design and construction cost estimate for the support facilities, and the conceptual design and cost of a multimodal container for hazardous wastes. The purpose of this task is to determine the feasibility, from a facilities standpoint, of operating an offshore incineration platform. The specific platform, Main Pass Block 254 "A" Structure of Chevron U.S.A., Inc., is located in the Gulf of Mexico approximately 100 kilometers (60 miles) south of Mobile, Alabama.

6.1 GENERAL DESCRIPTION

The facilities proposed for this system include:

- Onshore base
- Offshore platform
- Containers

The following description identifies the key points and general configuration of these facilities.

Onshore Base. Figure 12 is a view of the proposed shore site and Figure 13 is a detail of the support building. A shore base is required to be convenient to all modes of transport yet at a safe distance from inhabited areas. These requirements are not necessarily mutually exclusive but they will present a problem when the time comes for a site survey. Because the design concept is typical for the Gulf Coast area, it is shown as a rectangular plan with the requisite utilities and approaches for transport. This concept provides a reasonable basis for cost estimating. However, it is unlikely that a site will be found that will be as convenient to lay out. Section 6.3 contains the requirements and a detailed description of the shore base.

Offshore Platform. Figure 14 illustrates the baseline configuration of the incinerator facility located on the existing offshore platform. In this case, the offshore platform to be used is of limited size. Feasibility of the project depends upon whether or not the required equipment can be located on the platform. It is evident from the illustration that sufficient area is available. Certain subsystems were installed below the deck

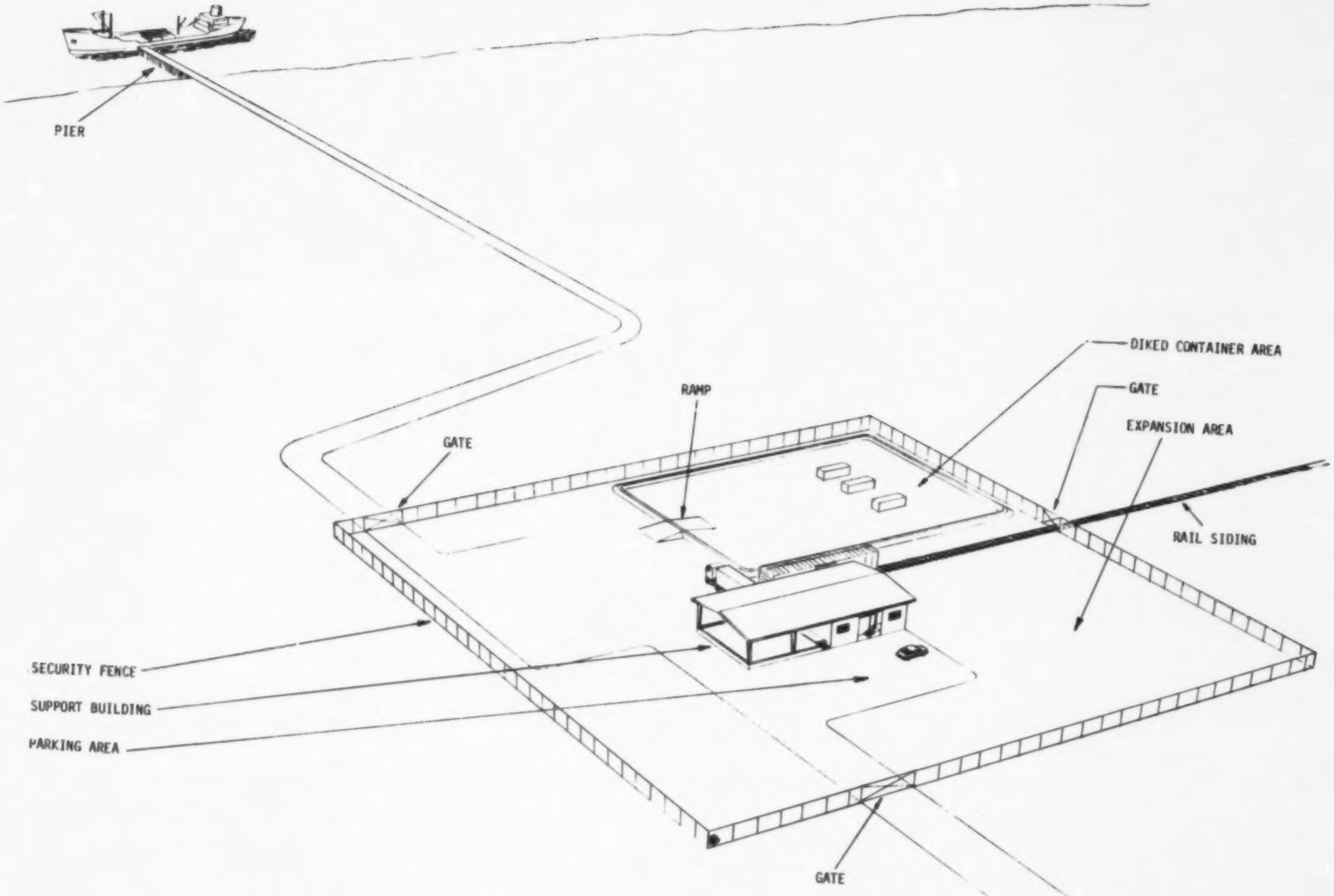
PIER
RAMP
DIKED CONTAINER AREA
GATE
EXPANSION AREA
GATE
RAIL SIDING
SECURITY FENCE
SUPPORT BUILDING
PARKING AREA
GATE

Figure 12. Site Layout of Onshore Facility

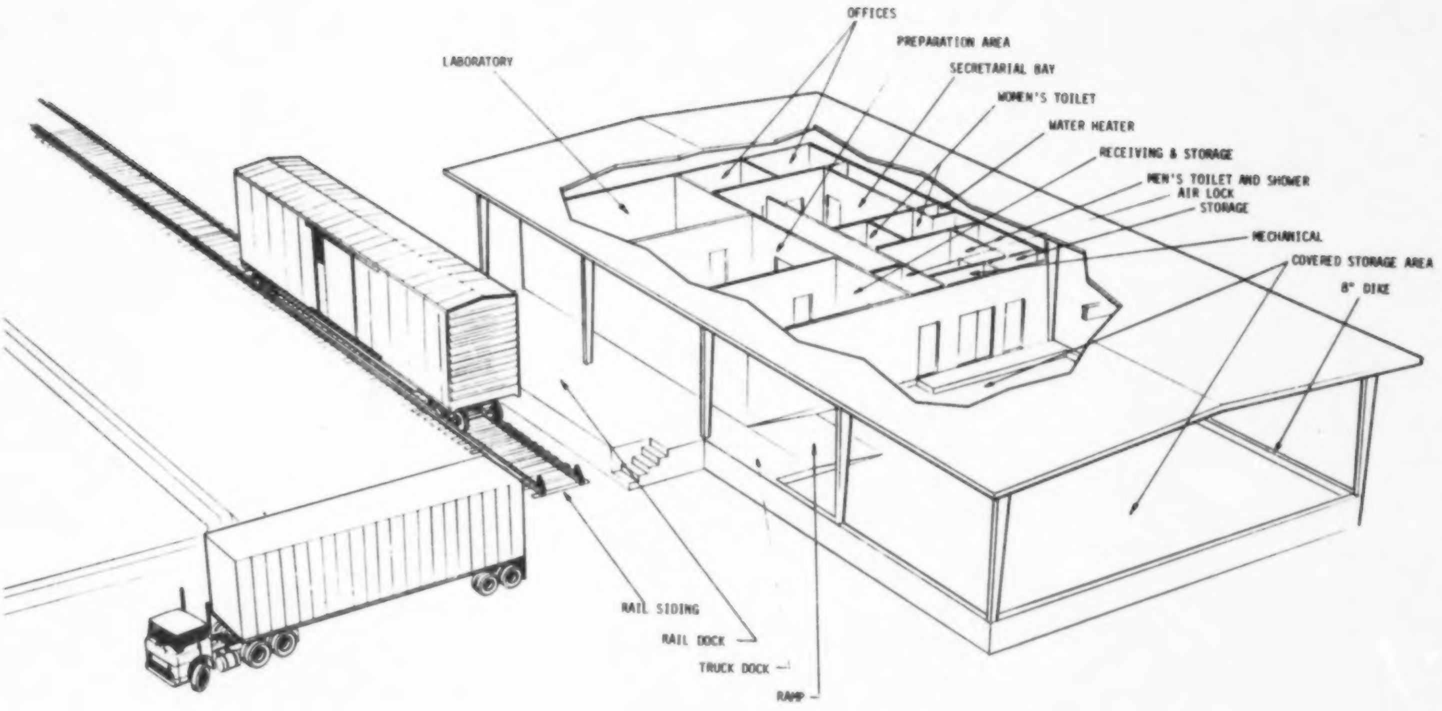
OFFICES
PREPARATION AREA
LABORATORY
SECRETARIAL BAY
WOMEN'S TOILET
WATER HEATER
RECEIVING & STORAGE
MEN'S TOILET AND SHOWER
AIR LOCK
STORAGE
MECHANICAL
COVERED STORAGE AREA
8" DIKE
RAIL SIDING
RAIL DOCK
TRUCK DOCK
RAMP

Figure 13. Detailed View of Onshore Facility

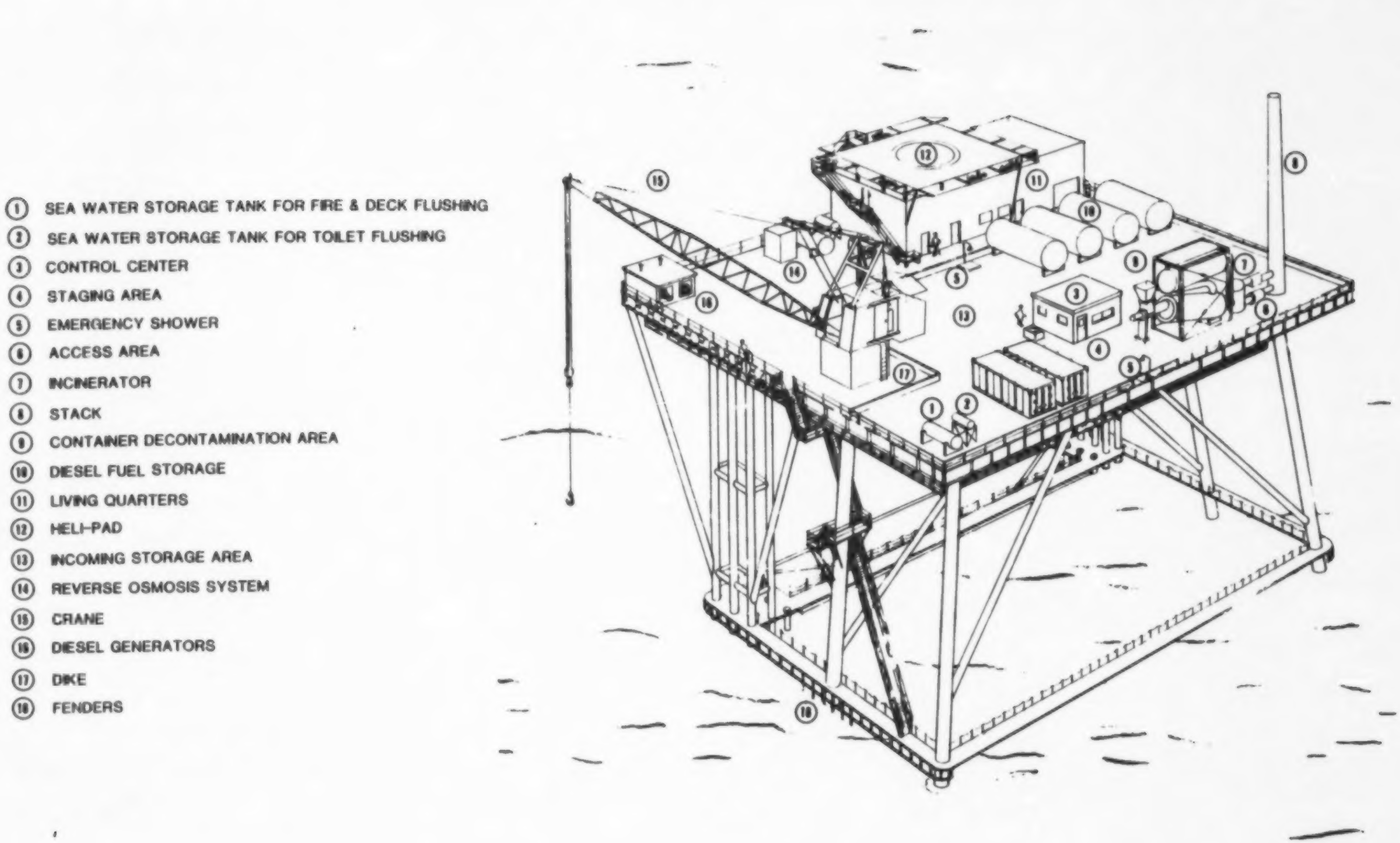
① SEA WATER STORAGE TANK FOR FIRE & DECK FLUSHING
② SEA WATER STORAGE TANK FOR TOILET FLUSHING
③ CONTROL CENTER
④ STAGING AREA
⑤ EMERGENCY SHOWER
⑥ ACCESS AREA
⑦ INCINERATOR
⑧ STACK
⑨ CONTAINER DECONTAMINATION AREA
⑩ DIESEL FUEL STORAGE
⑪ LIVING QUARTERS
⑫ HELI-PAD
⑬ INCOMING STORAGE AREA
⑭ REVERSE OSMOSIS SYSTEM
⑮ CRANE
⑯ DIESEL GENERATORS
⑰ DIKE
⑱ FENDERS

Figure 14. Facility Layout of Offshore Facility

or existing platform tanks (underwater) were used to solve some of the problems; however, the concept proposed appears to be practical in every respect. Housing of the crew is provided by a pre-built structure, and a smaller shelter is used as a control center for the incinerator. Although the drawing indicates a single crane, there is a potential for use of more cranes. This is discussed in detail in Section 6.2.7. The storage and diked areas of the platform deck are based on the assumed production rates and the types of containers to be used. Mooring facilities are the same as when Chevron operated the platform. Although the illustration does not show all of the subsystem, e.g., safety devices, electrical, and mechanical equipment, these are discussed in detail below.

Containers. Containers are discussed at length in a separate section of this report (Section 6.4). At the time the baseline layout was made, the International Standards Organization (I.S.O.) 20-foot long container was the prime candidate for the system container; two of these containers were shown on the deck as an example of container storage. Subsequently, a smaller container has been proposed as the primary piece of equipment for the system. The major impact of this change is that the crane capacity requirements are less than the 20 tons required for a fully loaded I.S.O. container.

Baseline Assumptions. The following baseline assumptions apply to this report:

- Cost estimates are in October 1979 dollars.
- Structural integrity of the platform is to be determined by the USCG.
- The platform will be refurbished and the structure modified as required prior to the time these facilities are to be installed.
- All structural and design work above the deck is addressed in this report; all structural work below the deck has not been considered and will be under the purview of the USCG.
- The incinerator will be assembled on the platform.
- Construction costs applicable to the Gulf Coast area are used for estimating.
- Containers are not to be opened from the time they are filled until they reach the platform.

6.2 OFFSHORE FACILITY

Use of an offshore platform for incineration research and waste disposal depends on an evaluation of both the technological and economic factors determining feasibility. Once it has been determined that the project is environmentally sound, then the practicality of the idea becomes primarily a matter of technical feasibility and cost. The following sections are based on the premise of determining: (1) is the platform suitable for the task, and (2) if so, what is the cost to prepare it for use? This study will use as a baseline the amount of work to be done daily and the crew size required. These requirements determine the size of quarters required, power needed, and auxiliary subsystems involved. Because there is only a finite amount of space available on the deck, the major pieces of equipment must be sized and arranged in the most efficient and safest manner. After this layout has been made, it is necessary to decide on the amount of structural work that must be done to support these facilities. All of the supporting subsystems must be identified to the extent that the best alternatives can be selected and their costs estimated.

The technical feasibility of using the Chevron platform for the purpose intended is well-documented in the following pages. It is possible to support the crew and to maintain the equipment as an efficiently operating entity. The cost for doing this is presented in Section 6.5.

6.2.1 Facility Layout

A preliminary design for the offshore platform was shown in Figure 14. This drawing shows most of the equipment that would be placed on the deck. There will be some pieces of equipment, which are not shown, below deck. These locations are only tentative, as a structural verification will be needed before any additional design is completed.

Figure 15 is a scale plan of the top deck. The layout of the deck and the placement of the components is dependent upon their interrelationship during operation and the safety aspects of the incinerator location. It was necessary to locate the incinerator downwind as far as possible

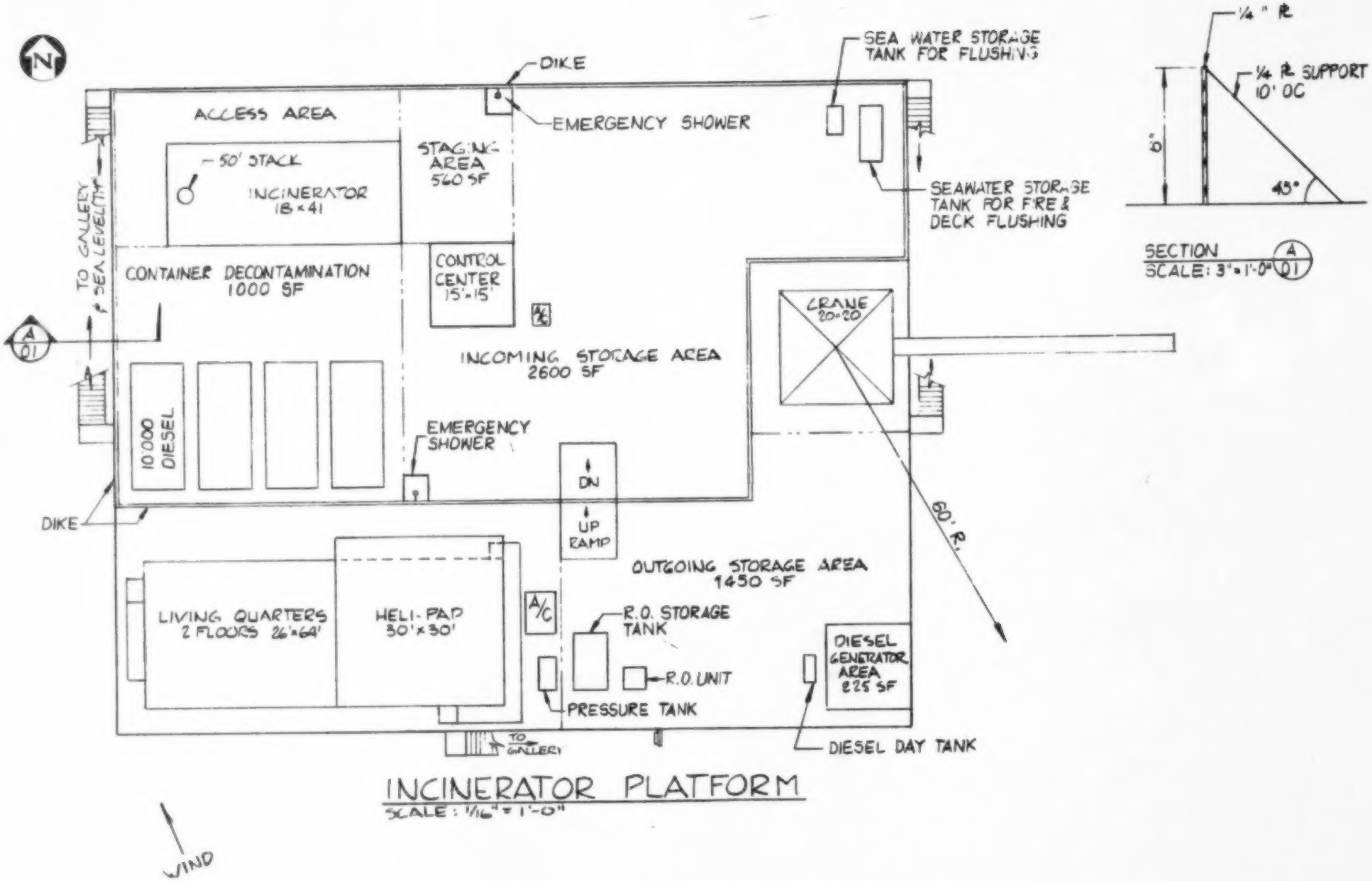
INCINERATOR PLATFORM
SCALE: 1/16" = 1'-0"
ACCESS AREA
50' STACK
INCINERATOR 18×41
STAGING AREA 560 SF
DIKE
EMERGENCY SHOWER
SEA WATER STORAGE TANK FOR FLUSHING
SEAWATER STORAGE TANK FOR FIRE & DECK FLUSHING
TO GALLERY ℄ SEA LEVEL
CONTAINER DECONTAMINATION 1000 SF
CONTROL CENTER 15'×15'
A/C
INCOMING STORAGE AREA 2600 SF
CRANE 20×20
10,000 DIESEL
EMERGENCY SHOWER
DN
UP RAMP
60' R.
DIKE
OUTGOING STORAGE AREA 1450 SF
LIVING QUARTERS 2 FLOORS 26'×64'
HELI-PAD 30'×30'
A/C
R.O. STORAGE TANK
R.O. UNIT
PRESSURE TANK
DIESEL GENERATOR AREA 225 SF
DIESEL DAY TANK
TO GALLERY
WIND
N
A
01
1/4" ℞
1/4 ℞ SUPPORT 10' OC
6'
45°
SECTION
SCALE: 3" = 1'-0"

Figure 15. Offshore Platform Plan View

because of smoke and toxic vapor hazards as well as to minimize the potential for fire and explosion. The incinerator was, therefore, placed in the northwest corner of the platform to satisfy these requirements.

Access area and clearance for the incinerator was assumed to be 10 feet on the sides exposed to the ocean. The incinerator foot print is 18 x 41 feet and will project slightly into the staging area. The staging area, shown on the drawing as 560 square feet, is a flexible area used for opening containers, preparing for incineration, and container unloading into the shredder and/or incinerator. Adjacent to the staging area is the control center where the operation of the incinerator is monitored. An emergency shower is located in the staging area next to the edge of the platform. The shower will be a flood-type overhead shower. Gray water waste from the emergency shower will be piped to the container and deck decontamination system since it will be considered contaminated. The area from the control center to the crane within the dike system is designated the incoming storage area. Approximately 2600 square feet are available for storage, exclusive of aisleways. More specific details are discussed in the section on storage areas.

Located in the northeast corner of the platform are the storage tanks for the seawater system. Two tanks will be required. One will be a 120 gallon tank for the marine toilet flush and the other will be a 1000 gallon tank for deck flushing and fire suppression. Both tanks will be mounted 3 to 4 feet above the deck on steel cradles. These tanks will be filled and pressurized by pumps located on the sea level platform.

The crane for the platform is located in the middle of the east edge of the platform. This location gives the best coverage for the operations that require the use of the crane. Next to the incinerator and the control center is the container decontamination area. This area, containing approximately 1,000 square feet, is where containers will be cleaned if they are not to be incinerated. Specialized equipment for cleaning drums and containers will be located in this area as well as storage for drums waiting to be cleaned. The decontamination area will have a small 3,000 gallon sump to collect rinse liquids, which will then be pumped into the incinerator for disposal. The tank will be located below the main deck because it will be filled by gravity feed. The pump that will connect the sump with the incinerator will be located on the main deck on a raised platform 1 foot high.

Diesel fuel storage will consist of four 10,000 gallon tanks placed next to the decontamination area. These tanks will be placed on steel supports close to the main deck and diesel fuel will be pumped to wherever it is needed. Spills or leaks of these tanks will be handled by the 3,000 gallon sump initially; if that is not adequate, the overflow can be piped into the container and deck decontamination system.

The dike system is constructed of 0.25-inch steel plates with 0.25-inch steel plate supports 10' on center (Figure 15). This dike system includes the northern half of the platform except for the area around the crane. The dike is 6 inches high and has a ramp near the living quarters for material movement.

The living quarters are located in the southwest corner of the platform. From a wind standpoint this is the best location because it is the furthest point upstream from the incinerator. The wind generally comes from the southeast; however, in the Gulf the wind may blow from any direction. Because of this, the living quarters will be capable of being totally sealed off from outside air for short periods of time. The living quarters will be located at a minimum of 6 feet from the edges of the platform. This allows for 3 foot walkways and a 3 foot width from exit stairs. (Codes require a 36 inch stair width for exit and minimum landing lengths of 36 inches.) There are three emergency exits from the second floor of the building; one terminates on the west side, one terminates on the south side, and one on the north side.

The remainder of the platform is used for outgoing storage, which is located in the southeast corner of the platform. This area is also used to locate equipment for the power system and the water purification plant. The actual usable space for storage is approximately 1450 square feet. This area is in addition to aisle space and space for the two subsystems mentioned above.

The potable water system will consist of three units located next to the living quarters. A primary reverse osmosis unit will be supplied with raw seawater from the seawater supply pumps. Potable water from the unit will then be stored in a tank located next to the reverse osmosis unit. This tank will be set on steel cribbing and anchored to the deck. This tank is 6 feet in diameter by 10 feet long and will supply water to the pressure set located next to the storage tank. The pressure set consists of a 3 foot diameter by 6 foot long tank and two pumps which provide the water system with the necessary pressure to supply the fixtures in the living quarters and elsewhere. These items will be located on the deck with no special mounting requirements.

The other system located in the outgoing storage area is the power generating system. It consists of two generator sets housed in a weather-tight enclosure located in the extreme southeast corner of the platform, and a small day tank 5 feet above the deck so that this tank can supply diesel fuel by gravity to the generators. The electrical switchgear will be located on the gallery level below the generators. This is on the same level as the previous switchgear but in a different location. It might be possible to utilize some of the existing cable trays on the platform if they are convieniently located. Access to the gallery level is by any of five stairways from the deck, and access to sea level is by way of two stairways. These stairways are part of the existing platform and are well placed, eliminating any need for additional ones.

6.2.2 Living Quarters

Living quarters are required for the personnel on the platform. It was assumed that:

- Factory built, portable buildings are to be used.
- Twenty persons would use the quarters in emergency, 12 normally.
- A shop would be required for electronic and mechanical maintenance.

- A laboratory will be required.
- Office space and communications will be required.
- Locker and shower facilities will be required.
- A heli-pad is to be located on top of the living quarters, if possible.
- Decontamination of personnel will be required.
- Observation windows will be required in the office.
- There will be a 2-week resupply cycle.

Because space is at a premium on any platform, it was decided that the best arrangement for living quarters would be two floors in height with a heli-pad on the roof. Overall dimensions were determined to be 64 feet long by 26 feet wide. This gave a compact structure with some semblance of comfort.

Buildings of this type are quite often used on platforms, and a number of firms are actively engaged in producing portable living quarters for similar purposes. Generally they are constructed with a steel and wood frame and then covered on the outside with fiberglass for saltwater corrosion protection. The interior wall surfaces can be of several materials, all of which are smooth and easy to maintain. These can be wood paneling, masonite, or plastic depending upon the purpose of the room. These buildings are normally fully erected at the manufacturers plant, placed on a barge and shipped to their destination where they are placed on the platform by a crane rented for that purpose. Building and placing structures in this manner has proven to be very economical because of efficiency in construction, outfitting, and shipping. In addition, construction at the platform is essentially eliminated, making it easier to schedule and use such units.

Figure 16 shows the basic layout for the living quarters. The ground floor is dedicated to operations and shower-locker facilities and the second floor has the living quarters, kitchen and recreation area.

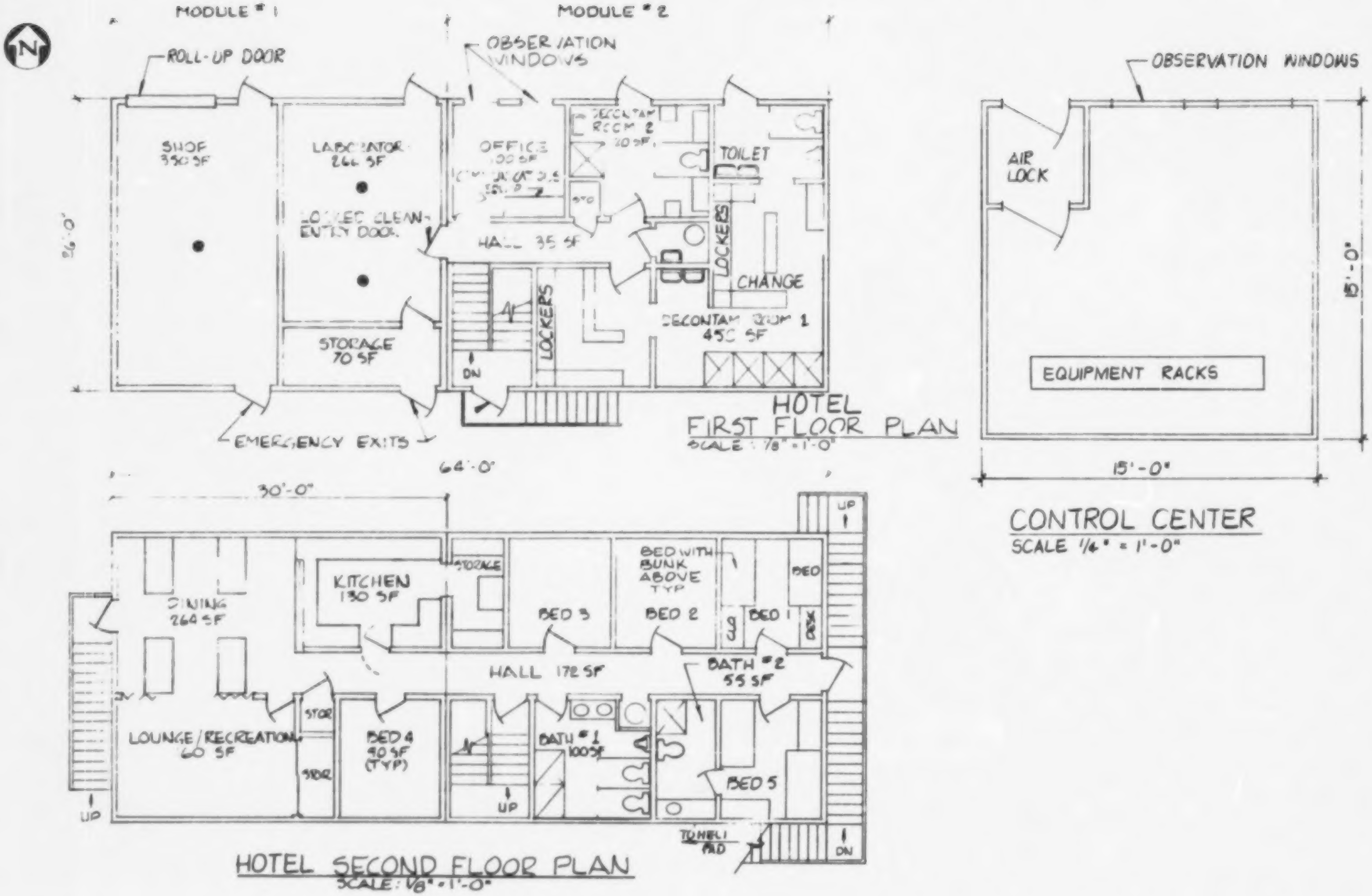
MODULE # 1
MODULE # 2
ROLL-UP DOOR
OBSERVATION WINDOWS
SHOP 350 SF
LABORATOR 266 SF
LOCKED CLEAN-ENTRY DOOR
OFFICE 100 SF
DECONTAM ROOM 2 20 SF
STO
TOILET
HALL 35 SF
LOCKERS
CHANGE
DECONTAM ROOM 1 450 SF
STORAGE 70 SF
DN
EMERGENCY EXITS
26'-0"
64'-0"
HOTEL FIRST FLOOR PLAN
SCALE: 1/8" = 1'-0"
OBSERVATION WINDOWS
AIR LOCK
EQUIPMENT RACKS
15'-0"
15'-0"
CONTROL CENTER
SCALE 1/4" = 1'-0"
30'-0"
DINING 264 SF
KITCHEN 130 SF
STORAGE
BED 3
BED WITH BUNK ABOVE TYP
BED 2
BED 1
BED
HALL 172 SF
BATH #2 55 SF
LOUNGE/RECREATION 60 SF
STOR
BED 4 90 SF (TYP)
BATH #1 100 SF
BED 5
TOWEL PAD
UP
DN
HOTEL SECOND FLOOR PLAN
SCALE: 1/8" = 1'-0"

Figure 16. Layout of Living Quarters (Hotel)

The ground floor has space for a shop, a laboratory, an office and decontamination rooms. Contamination control is the governing factor in the design of the lower floor. All employees are required to wear protective clothing when working on the platform. When they come into the living quarters to rest, eat or sleep they are required to remove their protective clothing, place it in lockers and shower. Then they are to put on clothes from another locker before being allowed to enter any of the "clean areas". To this end, approximately one-third of the ground floor is devoted to shower and locker facilities. Toilet and lavatory facilities are located so that employees can use them without going through the decontamination cycle. Two decontamination rooms are provided; Room #1 is designed for 15 persons and Room #2 is designed for 3 persons. Both rooms are airtight with air locks into the central hall.

The shop of 350 square feet will be used for platform maintenance, test set-up and electronic work. Access to the shop is through an 8 foot rollup door or a 3 foot manual door. There is one emergency exit each out of the shop and the laboratory. The laboratory encompasses 266 square feet with 70 square feet of storage off of the back of the laboratory. There is a safety door for emergency exit only from the hallway, which is a clean area, into the laboratory which is considered a dirty area. It will be locked from the laboratory side. The office occupies 100 square feet and is also used as a communications center. Observation windows are shown because there is a requirement for observing activity on the platform from a safe vantage point. It might be mentioned that there are no other windows shown on the plans. Other windows would normally be mandatory or desirable, but because of the preliminary nature of this report, they were not included. The main stairway is located inside the living quarters building affording better access control to the upstairs clean area and personnel safety. All outside stairways are either emergency exits or access to the helipad and roof. These exits will be locked from the outside at all times and the only access to the living quarters is through the decontamination area and up the internal stairs. Greater personnel safety is provided by internal stairs because there is concern that stack gases from the incinerator may suddenly shift and blow toward the living quarters thereby creating emergency conditions. It is felt that it would be safe to reach refuge on the ground floor and then go upstairs, if necessary, rather than having to use outside stairs in the dangerous environment.

The living quarters were placed on the second story for the reasons previously mentioned. The living quarters consist of bedrooms, toilets, kitchen-dining room, and recreation/lounge area. There are five bedrooms, each with two bunk beds. One of these bedrooms has a private bath adjoining it. All of the bedrooms have a small desk and a small closet. The main bathroom was sized for 16 persons using the 1976 Uniform Plumbing Code (UPC). The UPC requires two water closets, one urinal, two lavs, and three showers for 20 persons. The private bath off bedroom number 5 is sized for four persons, using UPC standards.

The kitchen was sized to serve 20 people at one time. It was assumed that the majority of the food would be of portion size and frozen. Therefore, a substantial frozen food locker would be required to store 840 servings of food. A refrigerator would be necessary as well as two microwave ovens and one drop-in electric oven. Other major kitchen equipment would include two sinks and a dishwasher capable of washing the dishes for 20 persons. Storage will be required and actual space will be determined as the final design is prepared. A serving counter will connect the kitchen to the dining room. Potable water is supplied as outlined in Section 6.2.11.

The dining room contains four dining tables, each capable of seating five comfortably in an area of 264 square feet. There is a safety exit in this room to facilitate evacuation if it becomes necessary. Adjoining the dining room is a recreation room of 160 square feet. This room can be partitioned off from the dining room by a folding divider which can be opened when a larger space is needed. In addition there is a large storage area for equipment at one end of the recreation room.

6.2.3 Control Center

A control center has been identified as being necessary for the safe operation of the incinerator. This building will house the controls and the recording devices for the incinerator as well as providing safety for the operators.

It was assumed that:

- The building would be small (15 x 15 feet).
- It would be located near the incinerator.
- It would have observation windows.
- It would be possible to isolate the structure from smoke intrusion for safety.

The location of the control center is very important because of its functions. It should be located as close as possible to the incinerator as well as close to the living quarters. A location between the incinerator and the living quarters and adjacent to the staging area was selected. From this location operators can monitor all pertinent areas. Figure 16 shows the basic layout of the building. An air lock is included for safety reasons since this building may be used as a refuge when hazardous substances are burned and the wind suddenly changes. Equipment racks are shown, however the exact number is not known at this time. The remainder of the building is devoted to general office space. Observation windows are shown on the side that faces the incinerator. Additional windows may also be required and must be considered.

Construction of the control center can be in one of three categories: fiberglass, pre-engineered or conventional. Marine conditions and safety must be considered.

A packaged fiberglass control center construction would be similar to the living quarters, i.e., steel and wood framing with a fiberglass exterior and interior materials to suit. A building constructed in this manner has the advantage of being built of materials that are known to be durable in a marine environment. The only drawback to this system might be cost. These types of buildings are relatively expensive compared to permanent onshore facilities because they are: (1) designed for marine environments, and (2) designed to be moved often from place to place.

Pre-engineered steel structures could very easily be adapted to the requirements of the control center. Several manufacturers supply buildings in the general size required for the control center. The greatest asset of these buildings is that they are inexpensive and almost an "off-the-shelf" item. However, installing interiors in these buildings is somewhat difficult and there may also be problems because the building has to be sealed off from the outside. Another drawback is that it is steel and regardless of protection it will have corrosion problems. How severely corrosion will affect the life of the building is not known at this time, but should be investigated when final design begins.

The last method would be to use conventional framing with wood or steel siding because it is easy to seal off and would probably outlast the pre-engineered type for about the same cost. It would definitely be less expensive than the fiberglass type and would be equally maintenance free. All three methods need to be analyzed to determine the system that most nearly meets the requirements and is the most economical.

6.2.4 Facility Environmental Control

Environmental control for the living quarters and control center on the platform will consist of central air-conditioning for the summer and resistance heating for the winter. For designing the system, the following ground rules and assumptions were made:

- Maximum summer design temperature 86°F at a dew point of 77°F (75 percent relative humidity)
- Minimum winter design temperature 50°F
- Interior temperature, summer, 78°F at a maximum relative humidity of 60 percent
- Interior temperature, winter, 65°F
- Conditioned air is supplied to the decontamination rooms at a rate of 400 cfm to provide an air change every 12 minutes. This air is not recirculated.

Two air conditioners will be needed, one for the personnel building and one for the control center. The air conditioner for the personnel building will require a nominal cooling capacity of 96,100 Btu/hr sensible heat. For winter heating, a 6 kW electrical resistance heater in the air conditioner will be needed. The air conditioner for the control center will require a cooling capacity of 55,900 Btu/hr total heat, virtually all sensible. A separate winter heater is not required for this building since the lights alone provide more than enough heat. In an emergency mode all make-up air ducts will be closed by dampers and the exhaust systems will shut down, closing off the building to intrusion of hazardous air.

Summer Cooling Analysis, Personnel Building

The heat load through the building structure was calculated for a July date at 2 PM using the methods and values given in the "ASHRAE 1977 Fundamentals Data Guide".* The air conditioner takes in 550 cfm of outside air to make up for the like amount exhausted by the kitchen range hood and decontamination room exhaust fans. The outside air and the building return air are mixed, filtered, cooled to an assumed temperature of 58°F, and then delivered to the building duct work by the air conditioner fan. The heat added to this air within the building raises its temperature to 78°F before it is returned to the air conditioner via the return air duct work. The heat load within the building is as follows:

	Latent	Sensible
Through structure		12,300
Lighting (50% on)		14,000
12 people	3,600	3,600
Chemistry lab		41,000
Food preparation		6,000
Air conditioner fan		6,000
Totals, Btu/hr	3,600	82,900

With a 20°F air temperature rise, this heat load requires a supply air flow rate of 3,875 cfm. Since 550 cfm is exhausted, the return air flow rate is 3,325 cfm. When the return air (78°F and about 50 percent relative humidity) is mixed with 550 cfm of fresh air (86°F and 75 percent relative humidity), the result is the following heat loads on the air conditioner evaporator coil:

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*Published by the American Society of Heating, Refrigeration, and Air Conditioning Engineers

	Latent	Sensible
Return air	3,100	71,800
Fresh air	26,200	15,600
Totals, Btu/hr	29,300	87,400
Add 10% safety factor	2,900	8,700
Capacity required, Btu/hr	32,200	96,100

An air conditioner is needed with a cooling capacity of 96,100 Btu/hr sensible heat and 128,300 Btu/hr total heat at an ambient temperature of 86°F when delivering about 4,000 cfm of 58°F air. The Carrier Model 50DD012 is a single package cooling unit and has adequate capacity for this load, requiring about 16 kW of electrical power.

Winter Heating Analysis, Personnel Building

The winter heating required was calculated assuming a 50°F nighttime ambient temperature and a nominal inside temperature of 65°F with no heat sources in the building (lights, people or technical equipment). The summer cooling fresh and return air flow rates were used (550 and 3,325 cfm, respectively), as were the heat transfer coefficients. The results were as follows:

Heat loss through structure	10,000 Btu/hr
Supply air flow rate	3,875 cfm
Temperature drop of supply air	2.4 °F
Return air temperature	65 °F
Supply air temperature	67.4 °F

To allow for adequate heating in the coldest room, assume a supply temperature of 70°F and an average return temperature of 67.6°F.

Return air flow rate	3,325 cfm
Return air temperature	67.6 °F
Heat added to return air	8,620 Btu/hr

Heat added to fresh air (50 to 70°F)	11,880 Btu/hr
Total heat added in air conditioner	20,500 Btu/hr
Subtract fan heat	6,000 Btu/hr
Net heat from electric heater	14,500 Btu/hr
Add 25% safety factor	3,625 Btu/hr
Minimum heater capacity	18,125 Btu/hr
Minimum capacity	5.3 kW

A 6 kW heater is recommended for adequate pulldown and to take care of infiltration and other uncertainties.

Cooling and Heating Analysis, Control Center

The summer heat load through the structure was calculated using the same methods as the personnel building. The latent heat load was not calculated separately because only two occupants were assumed, requiring a negligible quantity of fresh air. The heat loads are as follows:

Through structure	1,900 Btu/hr
Personnel	1,200 Btu/hr
Lighting	3,100 Btu/hr
Technical equipment (12.2 kW)	41,600 Btu/hr
Air conditioner fan	3,000 Btu/hr
Total	50,800 Btu/hr

Adding a 10 percent safety factor, the minimum cooling capacity of the air conditioner is 55,900 Btu/hr at an outside temperature of 86°F while delivering about 2,500 cfm of 58°F air. The return air temperature is 78°F. It is recommended that a packaged air conditioner be used, mounted on the deck adjacent to the east wall of the control center with short supply and return air ducts passing through the wall. The supply air duct carries air to a four-way register in the center of the room. A single return air grille in the east wall near the air conditioner is recommended.

For winter heating, assuming no heat sources in the room, the heat loss through the structure is only 1,500 Btu/hr. Turning the lights on would provide more than enough internal heat.

6.2.5 Power System

The electrical power system is outlined by the single-line diagram of Figure 17. The identified loads required are classified and tabulated in Table 10. The main components include two diesel generators, a main switchboard, motor control centers, transformers, cables, interior, exterior and emergency lighting.

When the operating scenario requires only facility loads, e.g., lighting, heating, ventilating and air conditioning, and the water and sewage systems, only one 300 kW generator will be on line. This generator provides a load of 222 kVA with 480/277 volts, three-phase, 60 hertz power. To operate the incinerator, a second 300 kW generator is added to the system.

TABLE 10. ELECTRICAL LOADS

	Mode	
Bus	Incinerator Operating Load (kVA)	Incinerator Off Load (kVA)
MCC-1	390	82
MCC-2 (Emergency Bus)	115.5	45
Air Conditioner, Personnel Bldg.	20	20
Air Conditioner, Control Center	10	10
Power Panel, Personnel Bldg.	25	25
Power Panel, Control Center	40	40
	600.5	222

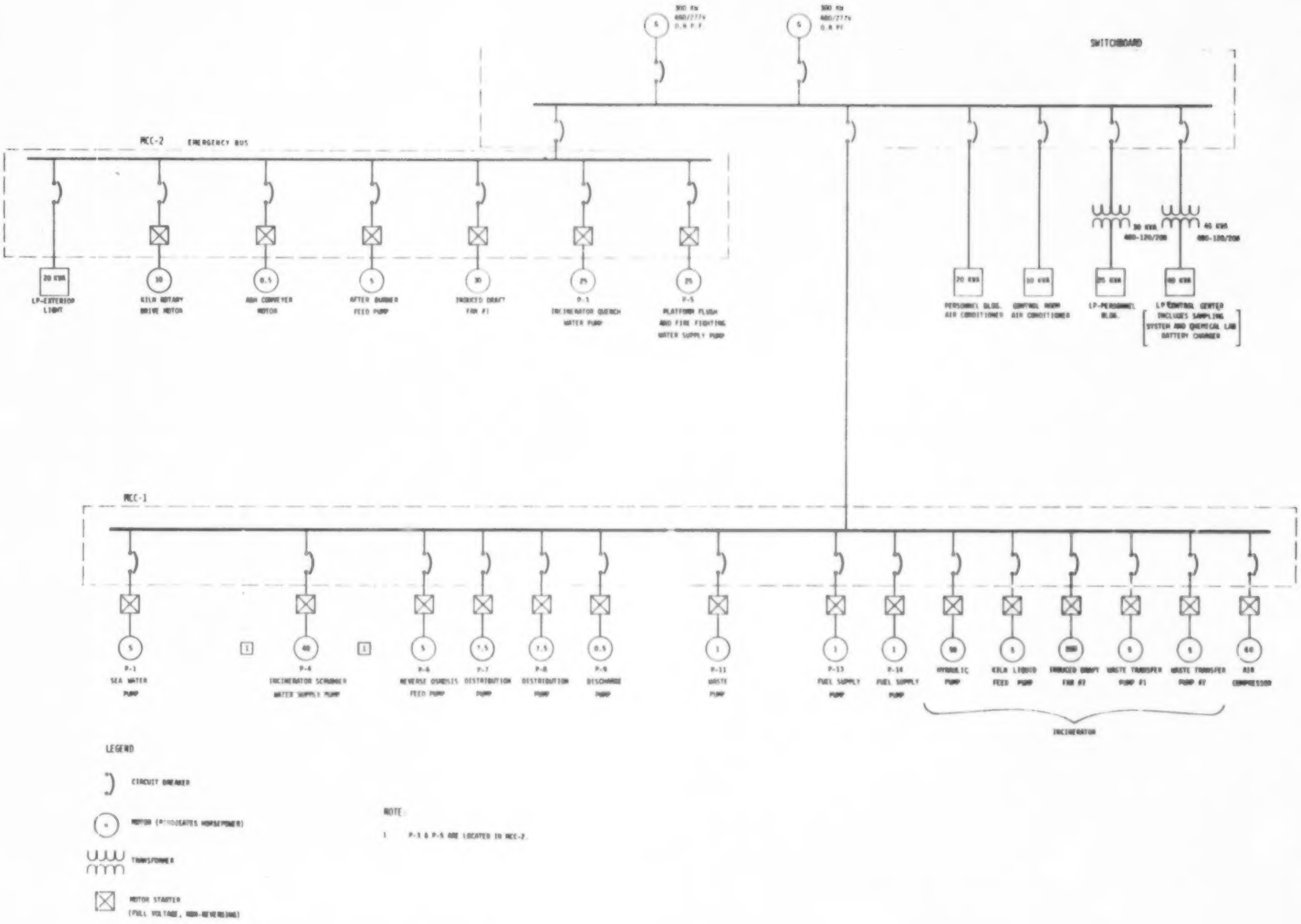
300 Kw
480/277v
0.8 P.F.
300 Kw
480/277v
0.8 PF
G
G
SWITCHBOARD
MCC-2
EMERGENCY BUS
20 KVA
LP-EXTERIOR
LIGHT
10
KILN ROTARY
DRIVE MOTOR
0.5
ASH CONVEYER
MOTOR
5
AFTER BURNER
FEED PUMP
30
INDUCED DRAFT
FAN #1
25
P-3
INCINERATOR QUENCH
WATER PUMP
25
P-5
PLATFORM FLUSH
AND FIRE FIGHTING
WATER SUPPLY PUMP
20 KVA
PERSONNEL BLDG.
AIR CONDITIONER
10 KVA
CONTROL ROOM
AIR CONDITIONER
30 KVA
480-120/208
25 KVA
LP-PERSONNEL
BLDG.
45 KVA
480-120/208
40 KVA
LP CONTROL CENTER
INCLUDES SAMPLING
SYSTEM AND CHEMICAL LAB
BATTERY CHARGER
MCC-1
5
P-1
SEA WATER
PUMP
1
40
P-4
INCINERATOR SCRUBBER
WATER SUPPLY PUMP
1
5
P-6
REVERSE OSMOSIS
FEED PUMP
7.5
P-7
DISTRIBUTION
PUMP
7.5
P-8
DISTRIBUTION
PUMP
0.5
P-9
DISCHARGE
PUMP
1
P-11
WASTE
PUMP
1
P-13
FUEL SUPPLY
PUMP
1
P-14
FUEL SUPPLY
PUMP
50
HYDRAULIC
PUMP
5
KILN LIQUID
FEED PUMP
200
INDUCED DRAFT
FAN #2
5
WASTE TRANSFER
PUMP #1
5
WASTE TRANSFER
PUMP #2
60
AIR
COMPRESSOR
INCINERATOR
LEGEND
CIRCUIT BREAKER
MOTOR (INDICATES HORSEPOWER)
TRANSFORMER
MOTOR STARTER
(FULL VOLTAGE, NON-REVERSING)
NOTE:
1 P-3 & P-5 ARE LOCATED IN MCC-2.

Figure 17. Electrical Single Line Diagram

The electrical equipment room located near the diesels on the gallery deck will house the switchboard and motor control centers. The switchboard will include metering and molded-case circuit breakers. Feeder cables from the electric equipment room will be routed below the platform and use the existing cabletrays if possible.

The personnel building and the control center will utilize fluorescent lighting as the principal light source. The lamps will be 40-watt, rapid start types having a standard cool white color characteristic. The lighting intensity will be 70 footcandles in offices and operating areas and 30 footcandles in other areas. In the event of loss of site power, battery operated emergency lighting units will permit safe operation.

Exterior lighting will be incandescent at a general level of 5 footcandles. In the vicinity of the incinerator, helipad, crane and diesel generators additional fixtures will provide a 30 footcandle lighting level. Since a loss of lighting would be dangerous, battery operated emergency lighting units will be strategically located throughout the platform.

In the event one of the diesels breaks down during incinerator operation, all buses except the emergency bus will be shed, allowing the remaining generator to bring the plant to a safe shutdown.

An uninterruptable power supply (UPS) is provided for critical control center loads such as valve controls, computer and data acquisition equipment. The motor control center emergency bus has not been supplied with UPS because it is believed that the system could withstand a short (from 10 seconds to 1 minute) outage in the event the on-line generator breaks down and while the second is brought on-line.

6.2.6 Compressed Air System

The compressed air system size is based upon the possible need to pneumatically convey bulk dry hazardous materials to the incinerator. In addition, a number of miscellaneous uses for compressed air emerged during the conceptual design of other systems. The total identified air requirements are:

1) Bulk solids pneumatic conveying

2) Instrument air

3) Valve actuation

4) Potable water system pressurization

5) Marine water closets seawater pressurization

6) Fire protection system pressurization

7) Possible aeration for sanitation systems.

The bulk solids transport requires the largest flow (75 scfm at 90 psi). All other requirements are well within this figure and peak simultaneous loads are handled by an accumulator.

It is common practice to provide compressed air as a utility on offshore platforms, and it is expected that additional uses for such things as pneumatically operated tools and laboratory and shop equipment will be identified in a future effort.

The units available for this purpose are completely packaged and skid mounted, including all components. As an example, the Ingersoll-Rand Model SSR-2000 is a unit which has been previously used on offshore platforms and will meet the requirements of this installation.

6.2.7 Material Transport

Vessel Mooring and Fendering System

For this report the following assumptions were made relative to transportation operations:

- Normal operation requires 200-500 metric tons of waste to be delivered every 2 weeks.
- 40,000 gallons of diesel fuel are delivered on the same boat.

- Maximum size vessel will be similar to the Acadian Mariner Class,* i.e.; 222 ft. long, 44 ft. breadth, 800 metric tons deck load.
- Personnel will be moved by helicopter although occasionally small craft will be used.
- Year-round operation except during bad weather.
- Cargo (hazardous wastes) will require special handling, certification, and insurance arrangements.
- All applicable USCG and EPA regulations will be met.
- The platform structure is sound and capable of withstanding mooring stresses of a boat similar to the Acadian Mariner.
- Fenders are in existence and are substantially as shown in Chevron Oil drawing No. D 16-6505-15

Mooring of vessels will depend to some extent on the size of the boat and the weather and sea conditions. A general description of the operation follows.

A vessel arriving at the platform for unloading or loading of containers must be positioned under the crane boom so that hoisting containers to and from the platform deck can be undertaken. If the sea is fairly calm and steady wind conditions exist, it will be feasible to unload a vessel without mooring. Such an operation would be greatly facilitated if the vessel were equipped with lateral bow and stern thrusters, as used on an increasing number of platform supply vessels. Under these conditions a shipmaster should have no difficulty in holding position near the platform.

If sea or wind conditions are less favorable, some system of mooring the vessel will be required. Three possibilities exist; mooring alongside, mooring stern-to, and mooring to buoys.

The first of these, mooring alongside, would be possible for vessels up to approximately 100 feet long in calm to average sea and wind conditions, assuming adequate fendering and mooring points. Some shifting of the vessel might be necessary in order to reach all the containers with a 100 foot crane boom. Warping of the vessel alongside will be performed by winches on the boat; none will be provided on the platform. The existing fenders are assumed to be adequate although larger boats may require additional equipment such as a "camel" (woven rope bumper) to prevent damage. Bitts (vertical posts) will have to be added to the structure since none appear on the drawings or photographs.

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*Information regarding this vessel was obtained from Mr. Lance Peterkin, Acadian Supply Ship, Inc., New Orleans, Louisiana, (504) 581-7880.

Larger boats, such as the Acadian Mariner, normally approach a platform from a safe distance, drop the bow anchor, and back toward the platform. Two 5-inch mooring lines are attached to the platform while tension is maintained on the anchor chain. The crane will be able to unload from the open deck in this position. For transferring diesel fuel there are very stringent requirements that must be met to insure that there are no spills. Some of this special equipment will be mounted on the platform as part of the diesel fuel storage system. If there are tide or high seas problems connected with this particular platform, it would not be unusual to install a mooring buoy to prevent damage and simplify the mooring operation.

Another mooring method, suggested by the USCG, utilizes a combined ramp and mooring system called the "Ryan Ramp". This is a combined gangplank and pivoting mooring device which holds a boat's stern away from the platform. The only objection to this method is that it requires an attachment to the boat. This means that one or more boats would have to be dedicated to servicing this platform.

Platform Material Transport

Material handling on the platform itself can be conveniently divided into two areas — loading and unloading of ships and handling of materials on the deck itself. A further subdivision can be by substance; i.e., liquid and solid. There are actually three classes of waste to be considered: liquid, dry granular, and solid masses requiring shredding before incineration. These three itmes are thoroughly discussed in the container section, Section 6.4, and will only be mentioned as they occur in this section. The essentials of handling analysis require that the material characteristics — size, weight, shape, condition, packaging — be known or estimated carefully. This problem is solved for the waste materials by specifying one or more standard containers to be used in all cases. If this can be accomplished, many of the handling problems disappear. All of the other materials required for operating an offshore platform — food, supplies, machinery, water, fuel — are to be handled using the standard methods normal to the industry in the Gulf area. For example, lifting these items 70 feet to the deck of the platform is best performed by a crane.

The size, type, and number of cranes to be used on the platform received an exceptional amount of attention during this project. Some of the correspondence and various proposals are included in Appendix B. The reasons for this situation are several:

- The crane is to be used for loading/unloading and for moving material about the platform. This requires a reach of approximately 100 feet.
- There is a need for a capacity of 10 tons at 100 feet. This was based on the original concept of using I.S.O. (International Standards Organization) containers, which have a maximum capacity of 20 tons; however, a need for more than a 10-ton capacity has not been identified.
- Maintenance of the incinerator and heavier subsystems may require a much greater capacity, possible as high 50 or 100 tons (at reduced radii).
- There is a strong cost incentive to provide a crane that can be used in the early construction phase to build the facility. This requires more capacity than is needed to operate the platform later.

Numerous suggestions were analyzed in the attempt to rationalize the above requirements; none was completely satisfactory. The baseline configuration for the handling system has been established as a 100 ton boom crane, diesel powered, with a minimum 100 foot boom length. The routine handling of materials on deck will be by forklift. The cost analysis section, Section 6.5, recommends that two cranes be installed on the platform. The reason for this is involved with the high cost of a derrick barge that is required to lift a large crane and emplace it on a platform.

Recent Gulf Coast experience indicates that, instead of a derrick barge, a small stiff-leg crane can be placed on deck by helicopter at a much lower cost. This crane is then used to emplace the larger crane. Both cranes can thereafter be used to service the facility. A further advantage is that the second crane does not have to be as large as it would ordinarily be. We recommend that this course of action be thoroughly investigated before a decision on the crane installation is made. The cost differential could be as high as $500,000 (see Section 6.5). A number of methods for mooring and unloading other than cranes were examined. Elevators, conveyors, and even roll on-roll off techniques were considered. These methods, while possibly less expensive than cranes, require extensive structural modifications on the platform. They also incur additional risks because high seas are a constant threat to structures built at the mooring level and would apply to all these methods. It should also be kept in mind that fuel and water (and in some cases, toxic liquids) are delivered by pumps through pipes to the storage tank. This is possibly the only exception to the use of a crane for unloading.

After containers of toxic wastes are unloaded and stored on deck, they will be moved to the incinerator area by forklift as needed. Here the liquid wastes will be pumped through a manifold arrangement directly into the incinerator. Empty containers will be moved to the cleaning area by forklift, decontaminated, and moved to storage. Steel drums are not to be reused, therefore they will be moved to a drum crusher, smashed to a convenient size, and stored for shipment. Dry materials in containers will be handled in the same way except that dumping into the incinerator/shredder will be performed by an unloader designed specifically for the task (see Section 6.4). This device in combination with a rotary air lock and airtight shrouds assures that the dry material will be fed into the incinerator without leakage. It is possible that some very bulky materials may be received in I.S.O. containers. In this case the crane will be used to handle the container throughout the process.

6.2.8 Storage Areas

Requirements for storage were limited to adequate space for incoming storage, container decontamination, and for outgoing storage. An additional requirement was that the incoming storage area be diked. In order to design or designate storage areas basic ground rules were developed:

- A minimum of 3 days storage for 24 hour/day operation
- Feed rates of between 3,300 and 6,600 lb/hr
- Baseline use of 55 gallon drums as containers.

Assumptions dealt mainly with operational considerations and waste classification.

It was assumed that:

- Toxic wastes have the consistency of oil.
- Loaded barrels can be stacked two high.
- Empty barrels can be stacked four high.

Flow of material on a platform is almost as important as the storage space itself. Referring to Figure 15 it can be seen that material to be burned is located between the crane and the incinerator. From there the material moves to the staging area where the containers are emptied. Empty containers are sent to the area adjacent to the incinerator where they are rinsed if necessary. If rinsing is not required, the barrels will go directly to the area for crushing and then to outgoing storage.

The maximum number of barrels to be stored over a 72 hour period (the baseline consumption period) was calculated to be 1,123 barrels. Each barrel requires 4 square feet of deck area or 4,492 square feet. Stacking barrels two high reduces this area to 2,246 square feet. The platform area designated for incoming storage contains 2,600 square feet, more than enough for the baseline consumption period. This is exclusive of aisle space, which has been laid out with access and material movement in mind.

The container decontamination area comprises 1,000 square feet; however, this area is to be used for decontamination equipment which has not been identified. Storage space has not been designated for the decontamination area but quite likely interim storage will be necessary since it may take longer to clean containers than to empty them. However, 1,000 square feet should be more than adequate for both decontamination equipment and interim storage; this has been provided.

The outgoing storage area located in the southeast corner contains 1,450 square feet of useful storage space. In order to store the same number of barrels required for incoming storage, this area would require 4,492 square feet as above. Stacking these empty barrels four high would reduce the area to 1,123 square feet, which is less than the available outgoing storage space now provided. Containers will be stored here and loaded onto container ships by the crane. At 1 square foot per barrel (if stacked 4 high), 1,150 square feet will accommodate 1,150 barrels.

6.2.9 Decontamination System

The decontamination system has been designed to fulfill two basic requirements: (1) contain toxic spills, and (2) clean containers of toxic residues. To satisfy these requirements a dike system was designed as well as washdown procedures and a sump system. In order to design these systems the following assumptions were made:

- The diked area and sumps are to have a minimum capacity of 25 percent of the maximum volume of stored fluid hazardous wastes.
- The drilling mud storage tanks, which are below sea level, can be used as emergency storage tanks.

The dike system includes the container decontamination area, the incoming storage area, the staging area and the incinerator. Figure 15 shows the extent of the dike, the ramp, and a typical cross section. The ramp is located between the incoming storage area and the outgoing storage area. It will be built of steel plate and will be primarily used by forklifts to move empty decontaminated containers to the outgoing storage area. The dike itself will be made from 1/4 inch plates, 6 inches high and supported every 20 feet by angular 1/4 inch steel plates. The control center and all other equipment within the diked area will be elevated a minimum of 12 inches above the platform. Figure 18 schematically shows the components of the decontamination system. In the storage

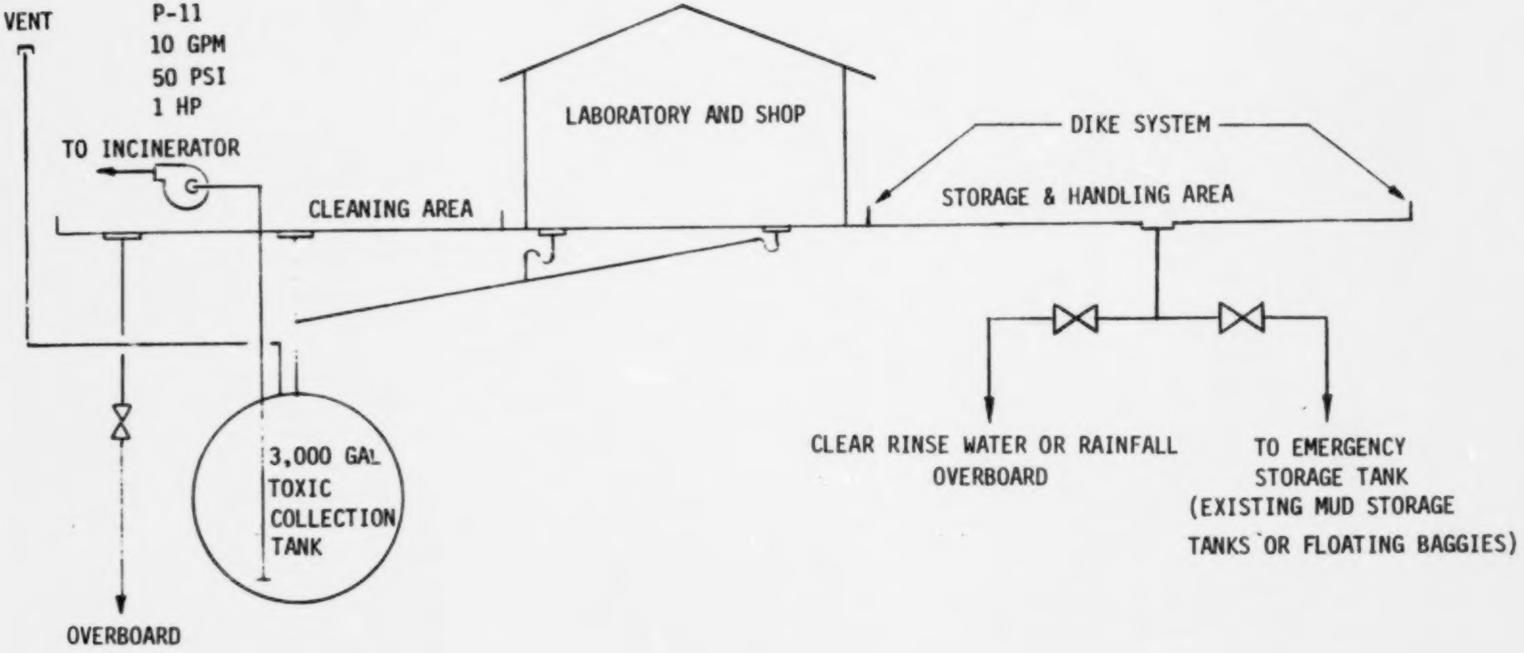

VENT
P-11
10 GPM
50 PSI
1 HP
TO INCINERATOR
CLEANING AREA
LABORATORY AND SHOP
DIKE SYSTEM
STORAGE & HANDLING AREA
3,000 GAL
TOXIC
COLLECTION
TANK
OVERBOARD
CLEAR RINSE WATER OR RAINFALL
OVERBOARD
TO EMERGENCY
STORAGE TANK
(EXISTING MUD STORAGE
TANKS OR FLOATING BAGGIES)

Figure 18. Decontamination System Schematic

and handling area there will be floor drains which will empty directly into the sea. Also in this area will be drains to emergency storage tanks (existing mud storage tanks). If the tanks are not usable, an alternative method would be to use inflatible rubber tanks placed in the sea; these would be connected to the drain piping and moored to the platform. There will be regular overboard drains as well as drains to a 3,000 gallon collection tank. In addition, floor drains, with traps to prevent vapors from entering the building, will lead from the lab and shop areas of the living quarters to the vented collection tank. Wastes from this tank will be pumped directly into the incinerator by a 1 hp, 50 psi, 10 gpm pump.

The total diked area holds approximately 30,000 gallons if filled to overflowing; this is more than 75 percent of the maximum storage (wastes and diesel fuel combined) for the platform. General procedures require that all plugs in the diked area be closed at all times. A procedure will require flushing of the deck each day to maintain clean decks in the event of rain. When the decks are flushed, the plugs will remain in place until it can be determined that the rinse water is safe to dump overboard. In the event that the water is not safe, drains to the pumps will be opened. The cleaning area will produce most of the rinse liquid that will need to be incinerated.

The emergency procedure in the case of a large spill of contaminated material or diesel fuel requires that the deck drains be kept closed and the emergency drains to be opened. The emergency drains are piped through existing pipe (if available) to the underwater drilling mud tank. Here the material is stored until it can be pumped out to be incinerated. In the event of a crew member being contaminated, he will use the deck emergency shower to remove the contaminate which can also be piped to the underwater rank.

6.2.10 Potable Water System

Potable water is required to supply the fresh water needs of the platform crew. Water is required for drinking, for use in the galley in preparing meals and washing dishes, and for the frequent showers required by crew members involved in the disposal of toxic materials. Daily use in all of the washrooms also requires fresh water.

Water need is estimated at 75 gallons per day per crew member, based upon recommendations of Chevron engineering personnel and suppliers of offshore equipment. Based upon a maximum complement of 20 persons and a 7-day workweek, the fresh water requirement is estimated to be 10,500 gallons per week. This quantity of water is best supplied by equipment designed to desalinate seawater. In this case, a unit utilizing reverse osmosis (RO) water purification modules is recommended. These units are currently in use on offshore platforms generating fresh water for crew use. Generating fresh water by distillation of seawater with incinerator heat was ruled out due to the unknown duty cycle of the incinerator.

In addition to the water purification system, a storage tank is required to provide a buffer to supply peak demands and during equipment maintenance cycles. Also, a pressurization system is required to permit distribution of the fresh water to the various elevations on the platform and to provide adequate pressure for showers.

The above systems are available as skid mounted, packaged units for ease in transporting and connecting on an offshore platform. Companies which provide this equipment are Smith-Mabry Co. of Ventura, CA, and Alexander Heavy Marine Industries of Houston, TX.

This system is shown schematically in Figure 19. Pump P-1, located as near ocean level as possible, draws raw seawater from 10 feet under the surface through a screened pipe and pumps it vertically 70 feet through a check valve to pump P-6. Pump P-6, which is part of the reverse osmosis water purifier, supplies feed water to the purifier apparatus. Nonfiltered water or brine is dumped overboard and the filtered potable water is drained into a 2,000 gallon storage tank. The vented storage tank supplies water to pump P-7 which in turn supplies a pressurized 240 gallon surge tank. This tank is kept pressurized to 60 psi and is instrumented to regulate pressure and water level. The pressurized tank supplies potable water through a valve to the water distribution system which supplies showers and emergency showers, washrooms, galley and drinking fountains. The major equipment elements are described in Table 11. A spare pump, P-8, is provided as a backup because of the critical nature of the potable water supply.

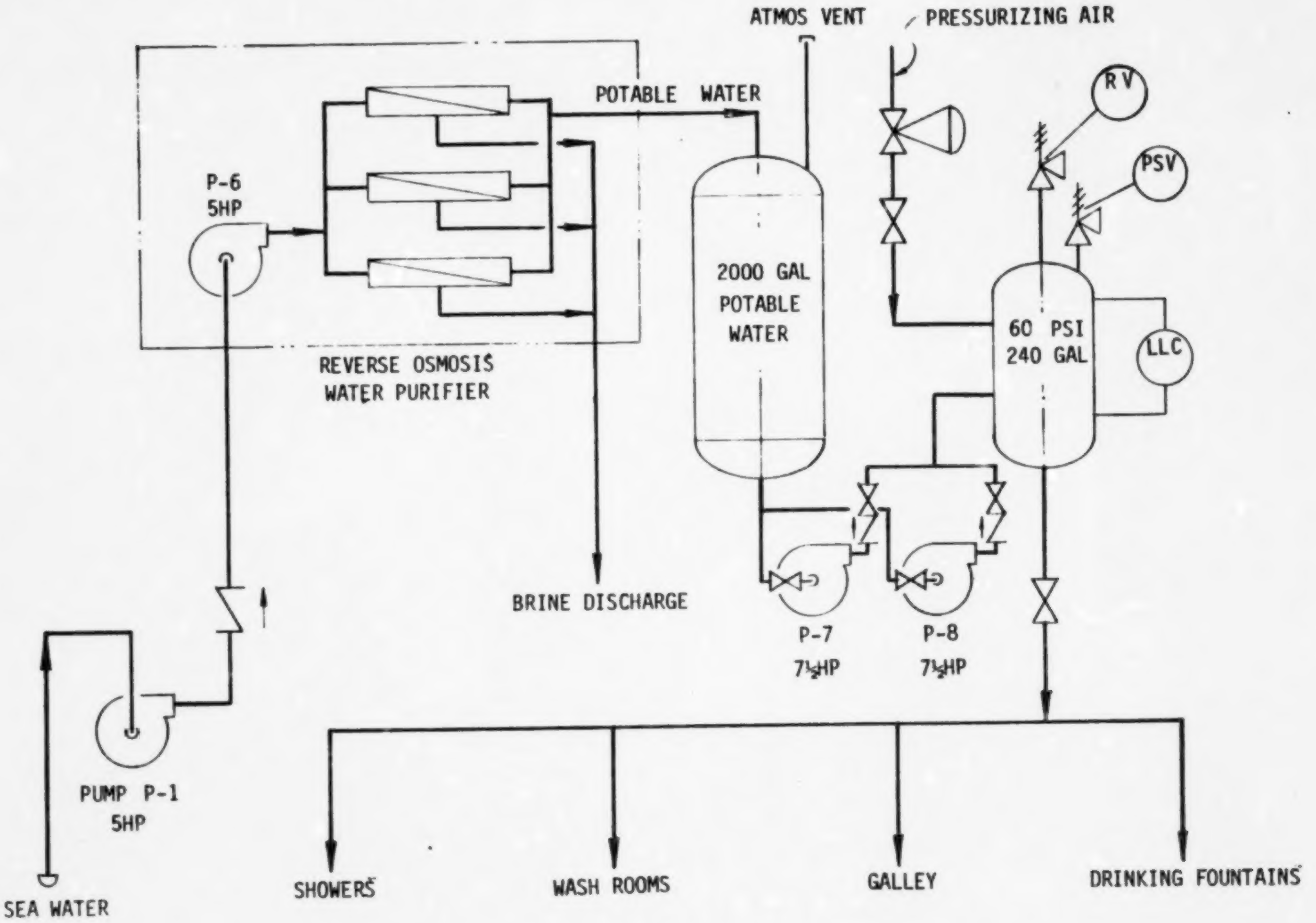

ATMOS VENT
PRESSURIZING AIR
POTABLE WATER
RV
PSV
P-6
5HP
2000 GAL
POTABLE
WATER
60 PSI
240 GAL
LLC
REVERSE OSMOSIS
WATER PURIFIER
BRINE DISCHARGE
P-7
7½HP
P-8
7½HP
PUMP P-1
5HP
SEA WATER
SHOWERS
WASH ROOMS
GALLEY
DRINKING FOUNTAINS

Figure 19. Potable Water System

TABLE 11. MAJOR MECHANICAL EQUIPMENT-POTABLE WATER SYSTEM

Item		Description	Size	Weight
1.	Seawater Pump (P-1)	(Described under seawater systems)		
2.	RO Feed Pump (P-6)	(Supplied with RO purifier 5 hp)		
3.	RO Purifier Unit	Skid mounted packaged unit 3 gpm potable water output	4' x 4' x 8'	2,000 lb
4.	RO Water Storage Tank	2,000 gallon galvanized steel tank; exterior epoxy marine coat	6' Dia x 10' LG	18,000 lb (full)
5.	Distribution Pump (P-7)	50 gpm, 100 psi centrifugal pump	2' x 4' x 2' H	200 lb
6.	Distribution Pump (P-8)	50 gpm, 100 psi centrifugal pump	2' x 4' x 2' H	200 lb
7.	Pressure Set	240 gal pressure regulated unit	3' Dia x 6' LG	2,500 lb

6.2.11 Sewage System

The sanitary sewage system consists of a collection, treatment, and discharge system for the showers, washrooms, marine water closets, galley and drinking fountains serving the living quarters where no toxic wastes are encountered.

A flow schematic is shown in Figure 20. Figure 21 shows a typical Coast Guard approved marine sanitation device. Figure 22 shows a marine sanitation system. The major components of this system are described in Table 12.

Platform discharges will be downcurrent from the platform intakes and will terminate 5 feet below the low tide level to provide separation.

Sanitary sewage systems used on offshore platforms are regulated by the USCG and are sized as a function of the platform crew size. In this case, the planning requirements are for a 20-man crew.

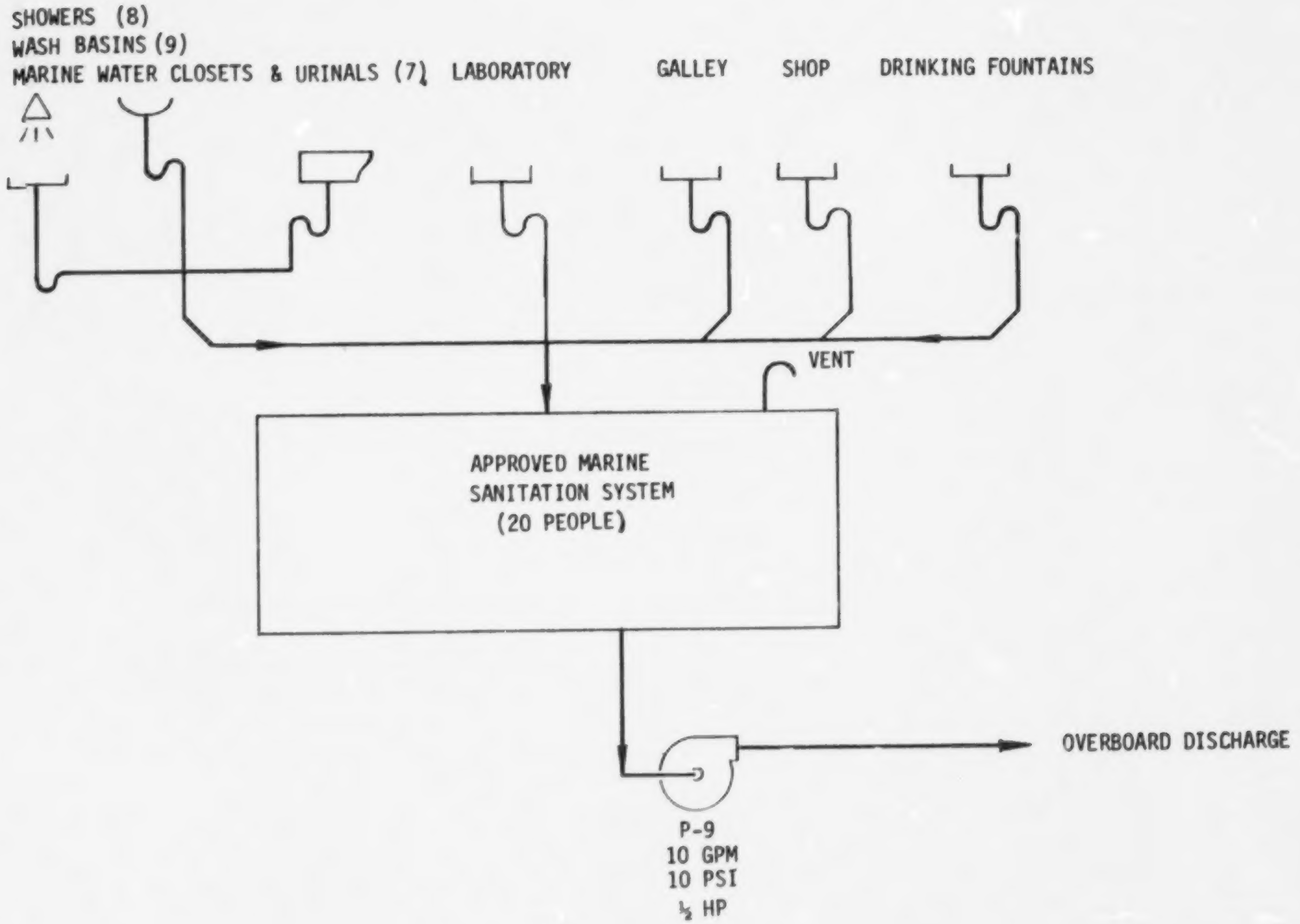
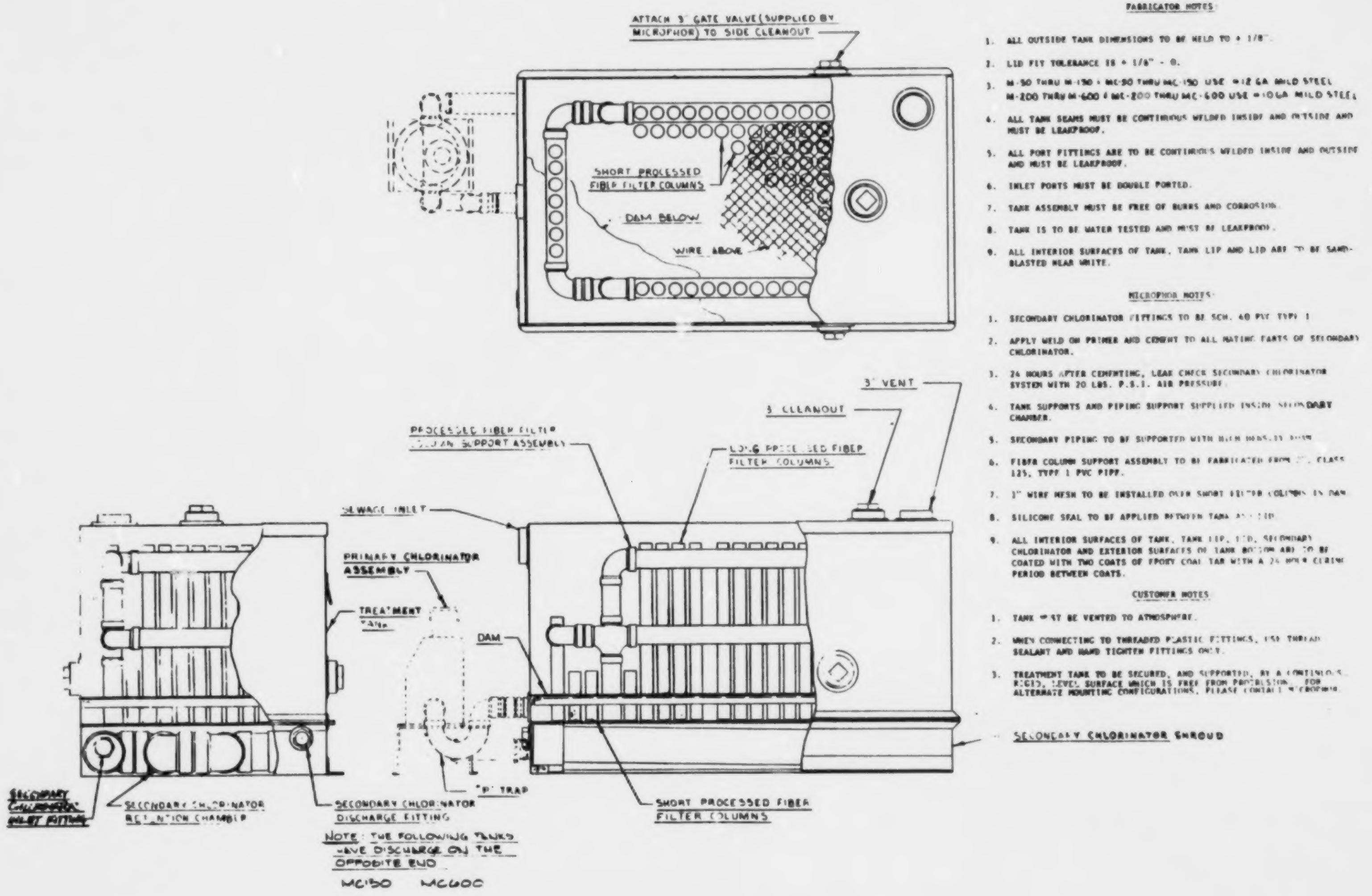

SHOWERS (8)
WASH BASINS (9)
MARINE WATER CLOSETS & URINALS (7)
LABORATORY
GALLEY
SHOP
DRINKING FOUNTAINS
VENT
APPROVED MARINE
SANITATION SYSTEM
(20 PEOPLE)
OVERBOARD DISCHARGE
P-9
10 GPM
10 PSI
½ HP

Figure 20. Sanitary Sewage System


ATTACH 3" GATE VALVE (SUPPLIED BY MICROPHOR) TO SIDE CLEANOUT
SHORT PROCESSED FIBER FILTER COLUMNS
DAM BELOW
WIRE ABOVE
3" VENT
3" CLEANOUT
PROCESSED FIBER FILTER COLUMN SUPPORT ASSEMBLY
LONG PROCESSED FIBER FILTER COLUMNS
SEWAGE INLET
PRIMARY CHLORINATOR ASSEMBLY
TREATMENT TANK
DAM
"P" TRAP
SHORT PROCESSED FIBER FILTER COLUMNS
SECONDARY CHLORINATOR INLET FITTING
SECONDARY CHLORINATOR RETENTION CHAMBER
SECONDARY CHLORINATOR DISCHARGE FITTING
NOTE: THE FOLLOWING TANKS HAVE DISCHARGE ON THE OPPOSITE END
MC150 MC600
SECONDARY CHLORINATOR SHROUD

FABRICATOR NOTES:

1. ALL OUTSIDE TANK DIMENSIONS TO BE HELD TO ± 1/8".
2. LID FIT TOLERANCE IS + 1/8" - 0.
3. M-50 THRU M-150 & MC-50 THRU MC-150 USE #12 GA MILD STEEL
   M-200 THRU M-600 & MC-200 THRU MC-600 USE #10 GA MILD STEEL
4. ALL TANK SEAMS MUST BE CONTINUOUS WELDED INSIDE AND OUTSIDE AND MUST BE LEAKPROOF.
5. ALL PORT FITTINGS ARE TO BE CONTINUOUS WELDED INSIDE AND OUTSIDE AND MUST BE LEAKPROOF.
6. INLET PORTS MUST BE DOUBLE PORTED.
7. TANK ASSEMBLY MUST BE FREE OF BURRS AND CORROSION.
8. TANK IS TO BE WATER TESTED AND MUST BE LEAKPROOF.
9. ALL INTERIOR SURFACES OF TANK, TANK LIP AND LID ARE TO BE SAND-BLASTED NEAR WHITE.

MICROPHOR NOTES:

1. SECONDARY CHLORINATOR FITTINGS TO BE SCH. 40 PVC TYPE 1
2. APPLY WELD ON PRIMER AND CEMENT TO ALL MATING PARTS OF SECONDARY CHLORINATOR.
3. 24 HOURS AFTER CEMENTING, LEAK CHECK SECONDARY CHLORINATOR SYSTEM WITH 20 LBS. P.S.I. AIR PRESSURE.
4. TANK SUPPORTS AND PIPING SUPPORT SUPPLIED INSIDE SECONDARY CHAMBER.
5. SECONDARY PIPING TO BE SUPPORTED WITH HIGH DENSITY [illegible]
6. FIBER COLUMN SUPPORT ASSEMBLY TO BE FABRICATED FROM [illegible] CLASS 125, TYPE 1 PVC PIPE.
7. 1" WIRE MESH TO BE INSTALLED OVER SHORT FILTER COLUMNS IN DAM
8. SILICONE SEAL TO BE APPLIED BETWEEN TANK AND LID.
9. ALL INTERIOR SURFACES OF TANK, TANK LIP, LID, SECONDARY CHLORINATOR AND EXTERIOR SURFACES OF TANK BOTTOM ARE TO BE COATED WITH TWO COATS OF EPOXY COAL TAR WITH A 24 HOUR CURING PERIOD BETWEEN COATS.

CUSTOMER NOTES

1. TANK MUST BE VENTED TO ATMOSPHERE.
2. WHEN CONNECTING TO THREADED PLASTIC FITTINGS, USE THREAD SEALANT AND HAND TIGHTEN FITTINGS ONLY.
3. TREATMENT TANK TO BE SECURED, AND SUPPORTED, BY A CONTINUOUS, RIGID, LEVEL SURFACE WHICH IS FREE FROM PROTRUSION. FOR ALTERNATE MOUNTING CONFIGURATIONS, PLEASE CONTACT MICROPHOR.

Figure 21. USCG Approved Sanitation System Installation

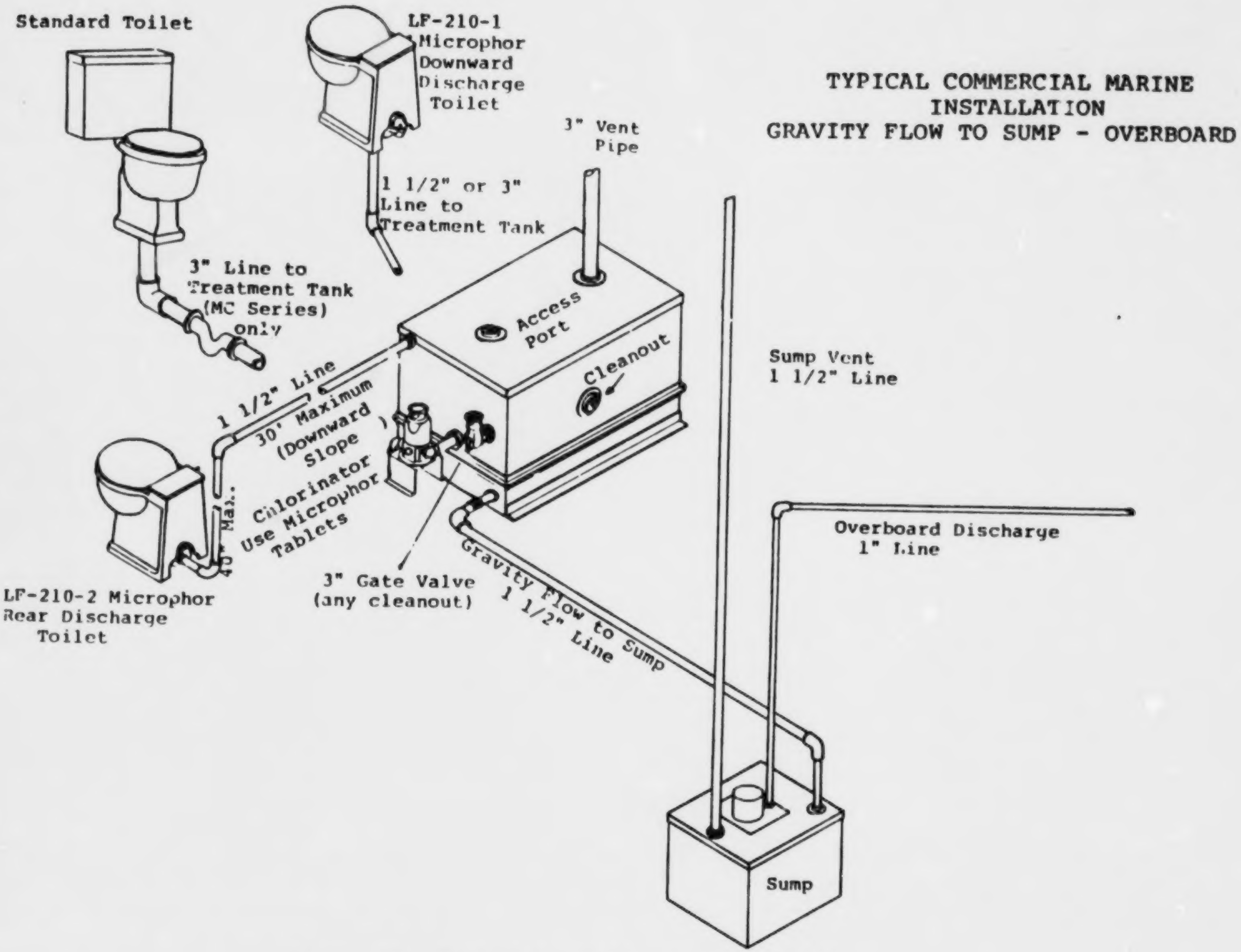

TYPICAL COMMERCIAL MARINE
INSTALLATION
GRAVITY FLOW TO SUMP - OVERBOARD
Standard Toilet
3" Line to Treatment Tank (MC Series) only
LF-210-1 Microphor Downward Discharge Toilet
1 1/2" or 3" Line to Treatment Tank
3" Vent Pipe
Access Port
Cleanout
1 1/2" Line
30' Maximum (Downward Slope)
4' Max.
Chlorinator Use Microphor Tablets
LF-210-2 Microphor Rear Discharge Toilet
3" Gate Valve (any cleanout)
Gravity Flow to Sump 1 1/2" Line
Sump Vent 1 1/2" Line
Overboard Discharge 1" Line
Sump

Figure 22. Typical Sanitation System Installation

TABLE 12. MAJOR MECHANICAL EQUIPMENT-SANITARY SEWAGE SYSTEM*

Item	Description	Size	Weight
1. Marine Sanitation System	Coast Guard approved Type II marine sanitation device for 20-man crew	4-1/2' x 9-1/2' x 3' H	1,650 lb
2. Discharge Pump (P-9)	Sewage discharge centrifugal type sump pump c/w level start/stop	2' x 2' x 2' H	100 lb
			1,750 lb

*Fixtures not included.

Approved Marine Sanitation Devices (MSD) are of three types defined as follows:

Type I Device - USCG certified to 1000 fecal coliform/100 ml, and no "visible floating solids" standard.

Type II Device - USCG certified to 200 fecal coliform/100 ml, and 150 mg/l total suspended solids standard.

Type III Device - USCG certified to no-discharge standard.

The Type I device is only allowed on installations existing prior to 30 January 1978. The Type III device is required on "inland navigable waters" and harbors. Type II is allowed for use outside the "inland navigable waters." In actual practice the USCG approves the Type II for use on offshore platforms. A Type III could be used, but is not recommended as it would create a hauling problem. A Type II system is selected as the recommended installation.

The approved Type II MSD's operate on basic biological principles. Waste is collected in a small aerobic flow-through sewage treatment plant in which solids are biologically digested and converted into liquid and carbon dioxide. The CO_2 is vented to atmosphere and the liquid effluent passes through a container of chlorine tablets before being released as a treated effluent.

6.2.12 Diesel Fuel Storage System

A diesel fuel storage system of considerable dimensions is needed to supply the various systems requiring fuel. The fuel storage system is sized to meet approximately 2 weeks of operation under normal conditions. The fuel requirements are estimated as follows:

Incinerator and/or afterburner	14,000 gal/wk
Power generator	3,000 gal/wk
Cleaning requirements and miscellaneous	2,000 gal/wk
Total usage	19,000 gal/wk
Required for 2 weeks	38,000 gal storage

The incinerator-afterburner estimate is extremely variable depending upon how much waste is being burned and the inherent heating value of the substance being burned. It has been estimated that the fuel contributes approximately 50 percent of the heating value needed to operate the incinerator and afterburner. Since it was assumed that most toxic materials to be incinerated are combustible, they will provide the bulk of the thermal energy required for complete combustion. Through experience the amount of fuel oil has been estimated to average 14,000 gallons per week. Emergency conditions could modify this estimate considerably if the right conditions are present; therefore, the storage tanks were sized at 40,000 gallons.

The storage capacity is provided by using four standard 10,000 gallon tanks. These are readily available, built with existing tooling, and their transportation, handling and installation are more readily managed than a single tank which would require on-site fabrication.

The fuel oil will be circulated through a loop with pressure maintained by a backpressure regulator in the return line. The four-tank arrangement permits isolation for filling while equipment is operating, reducing the possibility of generator or incinerator interruption.

The pumps will be positive displacement or turbine type pumps as generally used for fuel oil. They should be arranged for redundant parallel operation in order to insure that one pump is operable while one is down for repair. Figure 23 shows this system. The major components are described in Table 13.

A low level alarm should be provided on each tank to alert the control operator when the level is low.

TABLE 13. MAJOR MECHANICAL EQUIPMENT-FUEL STORAGE AND SUPPLY SYSTEM

Item		Description	Size	Weight
1.	Fuel Storage Tank	10,000 gal steel tank, acid and fuel oil resistant interior coated and marine exterior corrosion protection	9' Dia x 22' LG	80,000 lb (full)
2-4.	Fuel Storage Tank	Same as 1		
5.	Fuel Supply Pump (P-13)	10 gpm, 50 psi positive displacement fuel oil circulating pump	2' x 4' x 2' H	100 lb
6.	Fuel Supply Pump (P-14)	Same as 4		
7.	Backpressure Regulator	Fuel oil backpressure regulator 1/2" NPT	1' x 1' x 1' H	25 lb

6.2.13 Platform Safety System

The safety systems will be provided and/or designed to meet the following U.S. Coast Guard Regulations:

1) Rules and Regulations for artificial islands and fixed structures on the Outer Continental Shelf, Subchapter N. CG-320.

2) Fire Fighting Manual for Tank Vessels, CG-329.

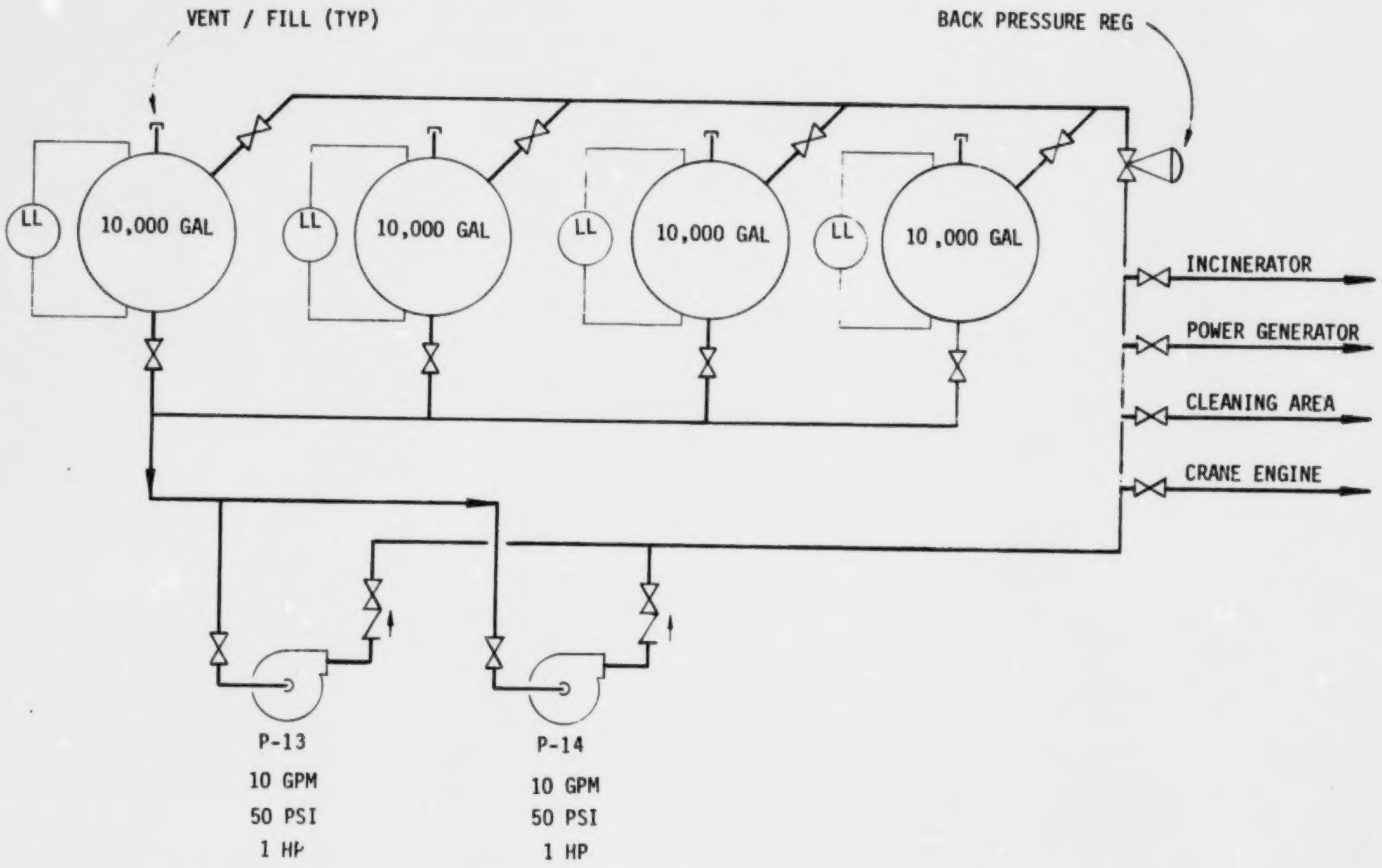

VENT / FILL (TYP)
BACK PRESSURE REG
LL
10,000 GAL
LL
10,000 GAL
LL
10,000 GAL
LL
10 ,000 GAL
INCINERATOR
POWER GENERATOR
CLEANING AREA
CRANE ENGINE
P-13
10 GPM
50 PSI
1 HP
P-14
10 GPM
50 PSI
1 HP

Figure 23. Fuel Oil Storage System

Aids to Navigation

The requirements for lights, fog signals and marking requirements are defined in CG-320 Appendix. It is assumed, since this is an existing platform, that the platform is presently equipped with the necessary installation and that arrangements exist for their maintenance and operation.

Storm Warnings

The platform will be equipped with communications equipment to maintain a constant weather update. The information will be used in planning and for curtailing incinerator runs, securing all equipment, and abandoning the platform should it become necessary.

Fire Fighting Equipment

The platform will be equipped with a number of types of fire fighting equipment. Fires are classed by type in CG-329 as follows:

> "Class A: Fires in ordinary combustible materials, such as mattresses, dunnage, piles of wood and shavings, canvas etc. These fires are best extinguished by the quenching and cooling effects of quantities of water or fog."
>
> "Class B: Fires in substances such as gasoline, oil, lubricating oil, diesel oil, tar, greases, etc. Here the blanketing or smothering effect of the extinguishing agent is of primary importance."
>
> "Class C: Fires in live electrical equipment, such as switchboard insulation, transformer terminals, etc. Here the extinguishing agents must be nonconducting so that electrical shock is not experienced by the fire fighter."
>
> "Class D: Fires in combustible metals such as magnesium, sodium, titanium, lithium, etc."

Fire fighting systems will include portable fire extinguishers in the living quarters, control room, decontamination area, and at each piece of equipment such as the crane, incinerator, diesel generator etc. The extinguishers will be suitable for extinguishing A, B, or C type fires as listed in Tables 14 and 15.

TABLE 14. FIRE EXTINGUISHER REQUIREMENTS

Space	Classification	Quantity and Location
	Safety Area	
Corridors	A-II	2 (one each level)
Communications Room	C-II	1
Control Room	C-II	
	Accommodations	
Sleeping Quarters		None
Lounge/Recreation	A-II	
	Service Spares	
Dining	A-II	1
Galley	B-II	1
Storage	B-II	1
Laboratory	B-II	1
Shop	B-II	1
Decontamination Area	A-II	1
	Machinery Spaces	
Diesel Generator	B-II C-II	1 1
Incinerator	B-II	2
Cleaning Area	B-II	1
Crane	B-II	1

TABLE 15. FIRE EXTINGUISHER TYPES

Classification		Soda-Acid and Water (gallons)	Foam (gallons)	Carbon Dioxide (pounds)	Dry Chemical (pounds)
Type	Size				
A	II	2-1/2	2-1/2	—	—
B	II	—	2-1/2	15	10
C	II	—	—	15	10

Two 100 gpm fire hoses with combination fog or solid stream nozzles will be provided for coverage anywhere on deck. Also a foam system will be provided at the fuel oil storage tanks and at the incinerator. A third foam system will be provided to cover the material storage area and the wash area.

Water Flush System

The deck fire hoses are also available for washing down any chemical spills. Emergency showers are provided for personnel in the working areas.

Life Saving Appliances

Life saving appliances consist of life floats, life preservers, ring life buoys, first-aid kits, litters, and emergency communication equipment. Approved life preservers will be provided for the maximum number of personnel (20). At least eight approved ring life buoys will be placed on the platform, two on each side. Ring buoys will be in easily accessible location and capable of being cast loose. They will not be permanently secured in any way. Each ring buoy will have an approved electric waterlight mounted in a bracket close by so that when the ring buoy is cast loose the waterlight will pull free of the bracket.

In accordance with CG-320, two life floats will be provided. Each of these life floats will accommodate 20 personnel. The units will be fully equipped in accordance with CG-320 paragraph 144.01-10. They will be located at opposite sides of the platform and be equipped with a proven launching system. Litters will be provided for injured personnel.

First aid kits will be located in the incinerator control center, laboratory, shop, and living quarters. A spare radio will be provided for emergencies in addition to the basic communications system.

Personnel Protective Equipment

Protective equipment for platform personnel will include respirators and self-contained breathing apparatus, protective disposable outer garments, decontamination areas, and emergency showers. Procedures for personnel protection are described in Section 5.3.4 of the Systems Operation Plan.

6.2.14 Structural Considerations

The purpose of the structural considerations portion of this report is to present preliminary structural loading criteria for the platform. In addition, some background information was completed on wind loading for the stack and other structures.

Wind pressure distributions for the area in question are on the order of 64 to 85 pounds per square foot. These pressures would result from 130 to 150 mph winds and a height above sea level of 120 feet for the incinerator stack. The South-East Uniform Building Code, 1979 edition, allows a shape factor of 0.7 for cylindrical objects to be applied for load reduction.

The design of the incinerator stack will obviously be the lead item and most critical of all the systems. It is suggested that not only rigid and breakaway designs be investigated, but also guy wires with an attachment ring. The ring could be located near the top or 1/3 point of the stack with guy wires coming down and attaching to the steel deck, hand rail and/or top of buildings in order to avoid obstruction of day-to-day operations. It is further recommended that all on-deck tanks be strapped securely and an enclosed cradle structure be considered to reduce uplift. If uplift is not a problem, then open skids or similar steel mounting devices will be adequate.

Structural design loads are composed of dead loads of equipment and live loads composed of any load which can be moved or is temporary. Dead loads for the given systems are obtained from the current data and are subject to change. Live loads are obtained from the International Conference of Building Officials UBC, 1976 edition. The systems considered do not include the existing offshore platform superstructure or the existing steel deck.

This following summary combines live load and deck load to give a total design load.

Incinerator	223,000 lb
Crane	200,000 lb
Living Quarters	341,000 lb
Helideck	*
Control Center	65,000 lb
Storage Areas	1,262,000 lb
Potable Water System	22,900 lb
Sanitary Sewage System	1,750 lb
Seawater System	11,400 lb
Fuel Storage	32,250 lb
Compressed Air System	*
Electrical Power System	33,500 lb

Summary Notes

The living quarters total was obtained by using the UBC 1976 Edition and Architectural Graphic Standards and is composed of the following:

Structure 20 PSF per floor X 2 = 40 PSF

Live load first floor average = 100 PSF

Live load second floor average = 45 PSF

Roof live load = 20 PSF

205 PSF Total

---

*See discussion on following page.

The control center was based upon:

Structure 20 PSF = 20 PSF
Roof live load 20 PSF = 20 PSF
Floor live load = 250 PSF
290 PSF Total

Heliport dead load will be determined by type of helicopters and anticipated payloads. The structure could be designed based on criteria from the ICBO's UBC, 1976 edition Section 2315 (Heliport and Helistop Landing Areas). The maximum stress induced from the following conditions should be used:

a. Dead Load (DL) landing area + weight of helicopter, or

b. DL of landing area + 1.5 fully loaded helicopter for an impact load distributed over a 1 square foot area. (This is for a helicopter with rigid or skid type landing gear. For a helicopter with hydraulic landing gear an impact factor of 0.75 is acceptable.) Or

c. DL + 100 PSF, with an allowable live load reduction (based on the formula in ICBO's UBC, 1976 edition Section 2306) of 0.08 percent per square foot of area supported by the member not to exceed 40 percent, or

$$R = 23.1\ (1 + D/L),$$

where

R = Reduction in %

D = Dead load acting on area supported by the member

L = Live load acting on area supported by the member

Design loads have not been determined for the helipad because the requirements for helicopter service have not been determined. Since the design of the pad itself is based upon the helicopter loads, this item has been left blank.

Compressed air system data are insufficient at this time. It has been suggested that an Ingersoll-Rand compressor Model SSR-2000 be used to meet the 75 scfm at 90 psi conditions.

The electrical system weights were estimated to be:

Generators 10,000 each X 2	= 20,000 lb
Switchgear	= 7,500 lb
Motor control	= 4,000 lb
Miscellaneous	= 2,000 lb
	33,500 lb Total

6.2.15 Seawater Supply System

Six seawater requirements have been identified

- Potable water
- Marine toilets
- Incinerator quench
- Incinerator scrubber
- Fire extinguisher
- Platform flush.

These requirements are satisfied with four seawater pumps set close to sea level in order to meet suction lift limitations (Figure 24).

Two of these systems are supplied by pump P-1 which supplies water to the potable water unit and the pressurization system for the marine water closets. A second pump (P-3) provides water to the incinerator quench system and is required to raise the water from sea level to the platform. This requirement exists only during operation of the incinerator which is sporadic in nature.

A third pump (P-4) provides water from sea level to the platform to feed the scrubber. The scrubber operates on an "as needed" basis during some, but not all, incinerator operation activities independent of the incinerator quench and must therefore be on independent call.

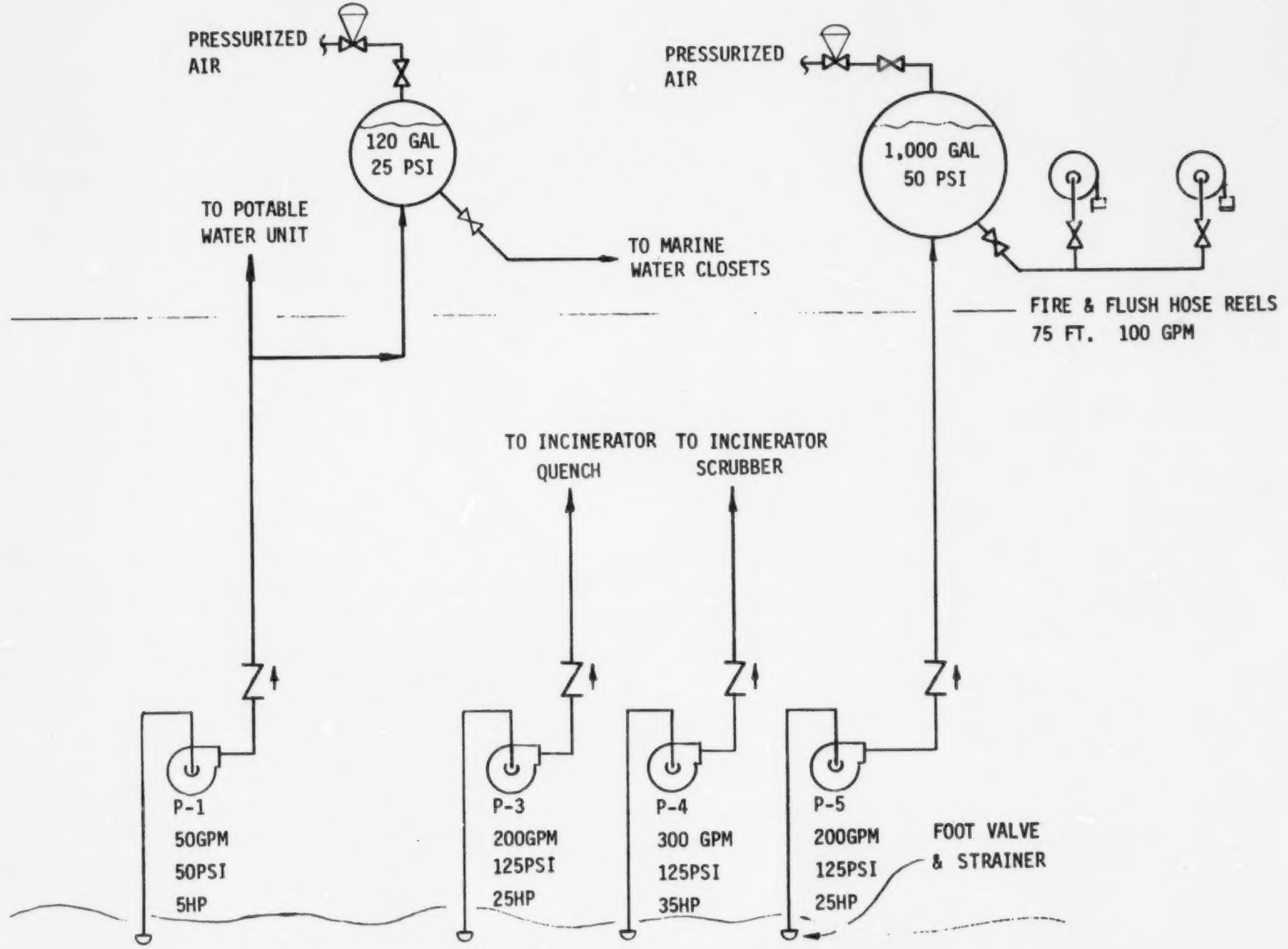

PRESSURIZED AIR
120 GAL 25 PSI
TO POTABLE WATER UNIT
TO MARINE WATER CLOSETS
PRESSURIZED AIR
1,000 GAL 50 PSI
FIRE & FLUSH HOSE REELS 75 FT. 100 GPM
TO INCINERATOR QUENCH
TO INCINERATOR SCRUBBER
P-1 50GPM 50PSI 5HP
P-3 200GPM 125PSI 25HP
P-4 300 GPM 125PSI 35HP
P-5 200GPM 125PSI 25HP
FOOT VALVE & STRAINER

Figure 24. Seawater Supply System

A fourth pump (P-5) provides water for fire fighting, deck flush and cleaning operations. For this purpose, a 1000-gallon pressurized tank is provided with a level control for automatically operating the pump when the tank level calls for water. The tank also is equipped with a pressurizing system to maintain tank pressure, along with the necessary pressure relief devices required for operation and required by code. This system also supplies two hose reels, each equipped with 75 feet of hose and a combination fog and solid stream nozzle. The reels are located to provide full deck coverage for both fire fighting and flushing of spills. Although not a part of this design, consideration should be given in subsequent design to adding a diesel driven pump in parallel with P-5 to supply seawater in case of total power loss.

General Considerations

All of the seawater pumps should be self-priming and made of materials compatible with seawater (i.e., stainless steel or plastic). Pumps will be piped and outfitted on suction and discharge lines with check valves to maintain prime during off periods in order to ensure flow when the pumps are turned on.

Piping and components will be of plastic materials to resist corrosion from seawater, except when supplying fire protection water. Fire protection water will be run in corrosion resistant steel pipe. These systems are shown schematically in Figure 24. The major components are described in Table 16.

6.3 SHORE BASED FACILITY

The on-shore ("shore based") facility is a central link in the total system which is designed to move hazardous wastes from a continental U.S. site to the offshore platform. A dedicated shore base is needed for this type of operation because of the nature of the wastes being moved. It is unlikely that free movement or temporary storage of these materials will be possible through the normal channels of common carriers. Because storage capacity on the platform is very limited, it is necessary to have a surge area available for storing wastes to be incinerated and also for containers awaiting return to the field. Under normal conditions, a biweekly shipment of material to the ocean platform is considered

TABLE 16. MAJOR MECHANICAL EQUIPMENT - SEAWATER SYSTEMS

	Item	Description	Size	Weight
1.	Potable Water System Supply Pump (P-1)	10 gpm, 50 psi seawater service rated centrifugal type pump	2' x 3' x 2' H	100 lb
2.	Marine Toilets Water Supply System Pressurizing Tank	120 gal steel tank rubber lined interior epoxy coated exterior	3' Dia x 5' LG	150 lb
3.	Incinerator Quench Water Supply Pump (P-3)	200 gpm, 125 psi seawater service rated centrifugal type pump	2' x 4' x 2' H	200 lb
4.	Incinerator Scrubber Water Supply Pump (P-4)	300 gpm, 125 psi seawater service rated centrifugal type pump	2' x 4' x 2' H	250 lb
5.	Platform Flush and Fire Fighting Water Supply Pump (P-5)	200 gpm, 125 psi seawater service rated centrifugal type pump	2' x 4' x 2' H	200 lb
6.	Fire Fighting and Flush Storage Tank	1000 gal pressurized storage tank. Fiberglass reinforced plastic rated 100 psi	4' Dia x 10' LG	10,000 lb (full)
7.	Hose Reel	C/W 75 ft - 1-1/2" rubber lined fire hose w/end couplings and fire nozzle	2' x 4' x 2' H	200 lb
8.	Hose Reel	Same as 8		

adequate. If an emergency occurs it may be necessary to ship wastes directly to the platform without passing through the shore base; however, this is not the normal mode. The shore base will serve as the scheduling and administrative offices for the platform. It also has the capability of performing chemical analysis of wastes. Special consideration has been given to safety in the storage and spill containment areas of the facility.

One primary caution to be kept in mind is that the following discussion is concerned with an ideal or "typical" facility. It does not exist in any real sense — it is, in fact, a pure concept which can be applied to any suitable piece of land in the Gulf Coast area. This concept has been estimated based on the best information available. These estimates are subject to all the variables that can affect the final location of the actual facility.

6.3.1 Facility Layout

The facility layout presented here must necessarily be an idealized form since no site has been selected. It is unlikely that any real site would be completely ideal and so featureless as to permit exactly the layout shown. The layout shown will, however, permit reasonably accurate costing if proper allowance is made for differences in the actual site.

The site shown, Figure 25, is 400 feet square (comprising 3.7 acres) and is envisioned as having compass north toward the side of the site having vehicular access to the street. This is arbitrary and may differ from an actual location but allows a neat and functional arrangement. The perimeter of the site is enclosed with 7-foot high chain link security fence topped with three strands of barbed wire. Rolling gates are provided at the street entrance, the rail siding entrance, and the point of access to the dock facilities.

Entering from the street gate, the access road, constructed of 1.5 inch asphaltic concrete on a 5.5 inch gravel subgrade, detail A/03, Figure 25, passes the Support Building at the open storage end, traverses a large paved staging and truck maneuvering area and exits through the gate leading to the pier.

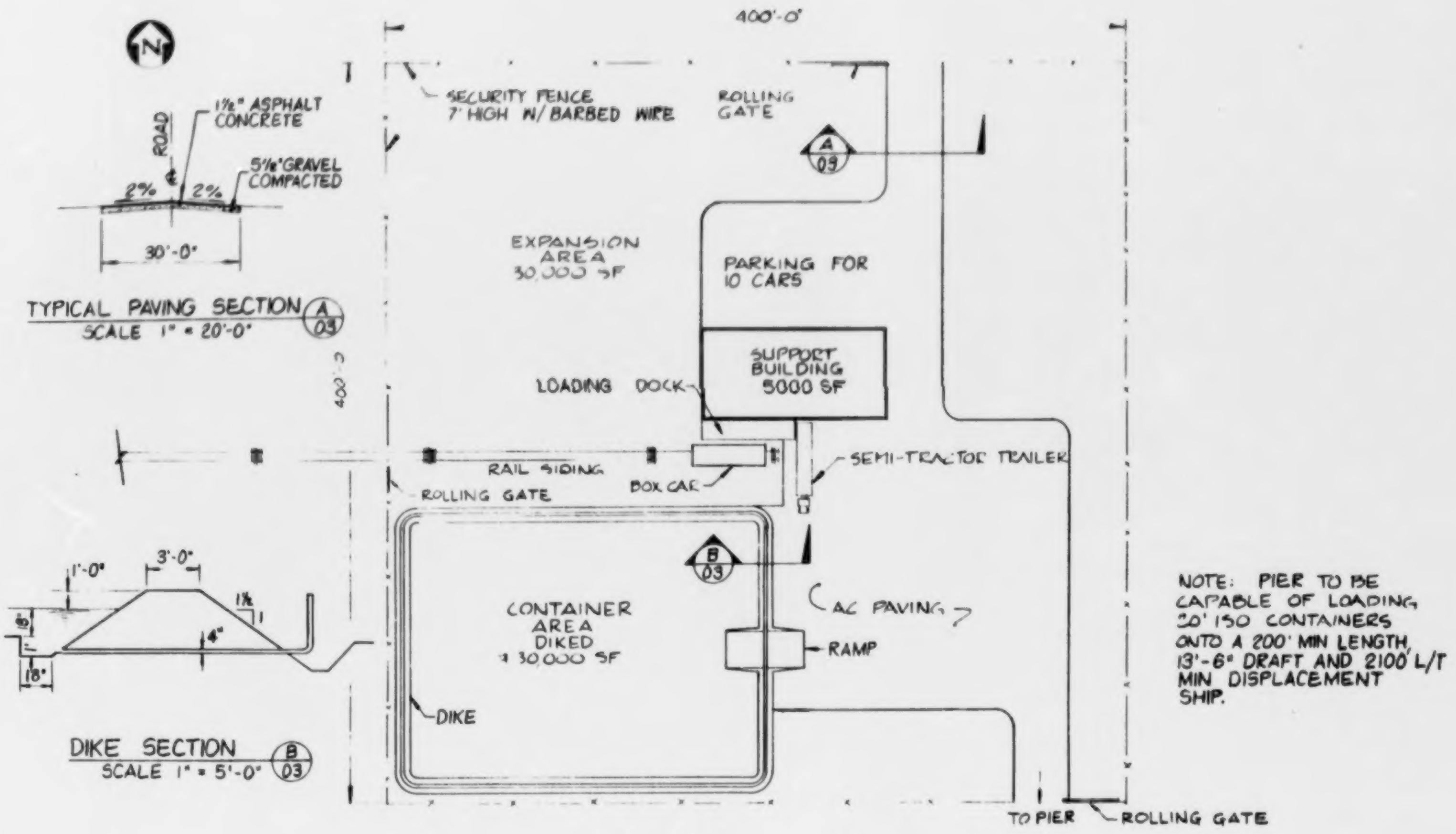

N
ROAD
℄
1½" ASPHALT CONCRETE
5⅛" GRAVEL COMPACTED
2%
2%
30'-0"
TYPICAL PAVING SECTION (A/03)
SCALE 1" = 20'-0"
1'-0"
3'-0"
1½
1
4"
18"
18"
DIKE SECTION (B/03)
SCALE 1" = 5'-0"
400'-0"
400'-0"
SECURITY FENCE 7' HIGH W/ BARBED WIRE
ROLLING GATE
A/03
EXPANSION AREA 30,000 SF
PARKING FOR 10 CARS
SUPPORT BUILDING 5000 SF
LOADING DOCK
RAIL SIDING
BOX CAR
ROLLING GATE
SEMI-TRACTOR TRAILER
B/03
AC PAVING
CONTAINER AREA DIKED ±30,000 SF
RAMP
DIKE
TO PIER
ROLLING GATE
NOTE: PIER TO BE CAPABLE OF LOADING 20' 150 CONTAINERS ONTO A 200' MIN LENGTH, 13'-6" DRAFT AND 2100' L/T MIN DISPLACEMENT SHIP.

Figure 25. Shore Based Support Facility Layout

The Support Building is located approximately in the center of the site with its long dimension on an east-west axis. The rail siding enters near the midpoint of the western perimeter and terminates at the rail dock. Both rail and truck docks are located at the south side of the Support Building.

At the southwest corner of the site, a container diked area of about 30,000 square feet is located. The interior of this diked area will be lined with reinforced concrete paving both to furnish a surface durable enough to withstand movement and storage of containers and to render the diked area dependably leakproof. A paved ramp over the dike gives access to the interior of the diked area.

An area of approximately 30,000 square feet is provided in the northwest portion of the site for future expansion.

6.3.2 Support Building

The Support Building has three basic functions to fulfill. First, it provides 2,000 square feet of enclosed habitable space for offices, lab, and toilets. Second, it incorporates truck and rail dock facilities. Third, it includes a roofed, unenclosed hazardous waste storage area, accessible to the truck and rail docks. The building design is based on an assumed occupancy of eight people on a one-shift, 8-hour day.

The total roofed area of the structure, not including eave overhangs, is designed as 5,000 square feet with gross floor dimensions of 50 by 100 feet (Figure 26). The layout is based upon use of a pre-engineered steel building with rigid frame structural supports at 25-foot intervals along the 100 foot dimension of the building (see Figure 27). The dimensions of the rigid frame shown in this drawing are typical of those used by various manufacturers of such structures but may vary a little, depending on which brand of building is ultimately selected. The finished floor elevation of the building will be about 4 feet above surrounding finished grade, the building itself being carried on concrete foundation walls extending a suitable distance below grade.

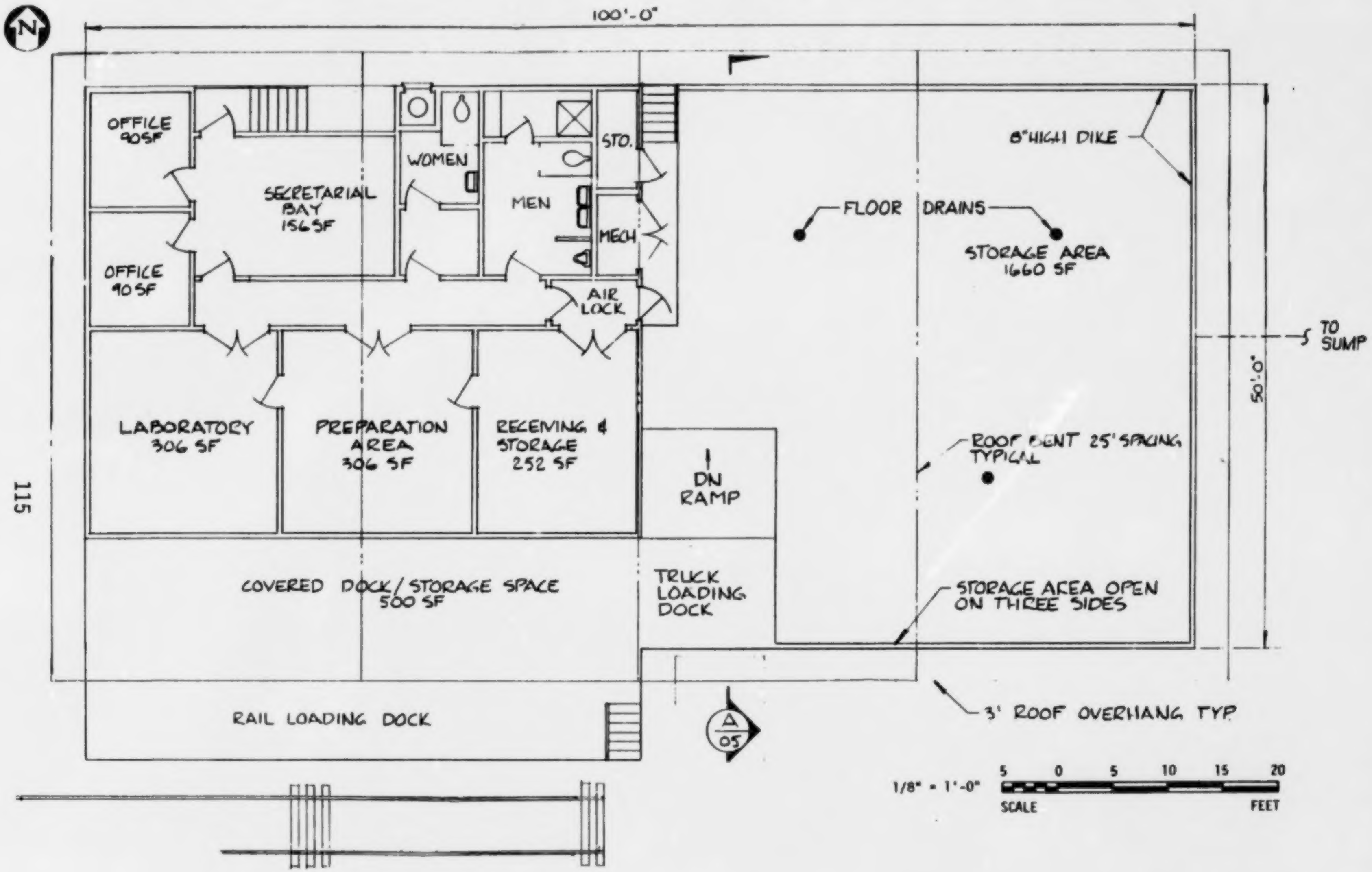

100'-0"
OFFICE 90SF
SECRETARIAL BAY 156SF
OFFICE 90 SF
WOMEN
MEN
STO.
MECH
AIR LOCK
LABORATORY 306 SF
PREPARATION AREA 306 SF
RECEIVING & STORAGE 252 SF
DN RAMP
COVERED DOCK/STORAGE SPACE 500 SF
TRUCK LOADING DOCK
RAIL LOADING DOCK
8"HIGH DIKE
FLOOR DRAINS
STORAGE AREA 1660 SF
TO SUMP
50'-0"
ROOF VENT 25' SPACING TYPICAL
STORAGE AREA OPEN ON THREE SIDES
3' ROOF OVERHANG TYP
A
05
1/8" = 1'-0"
5
0
5
10
15
20
SCALE
FEET

Figure 26. Shore Based Support Building Layout

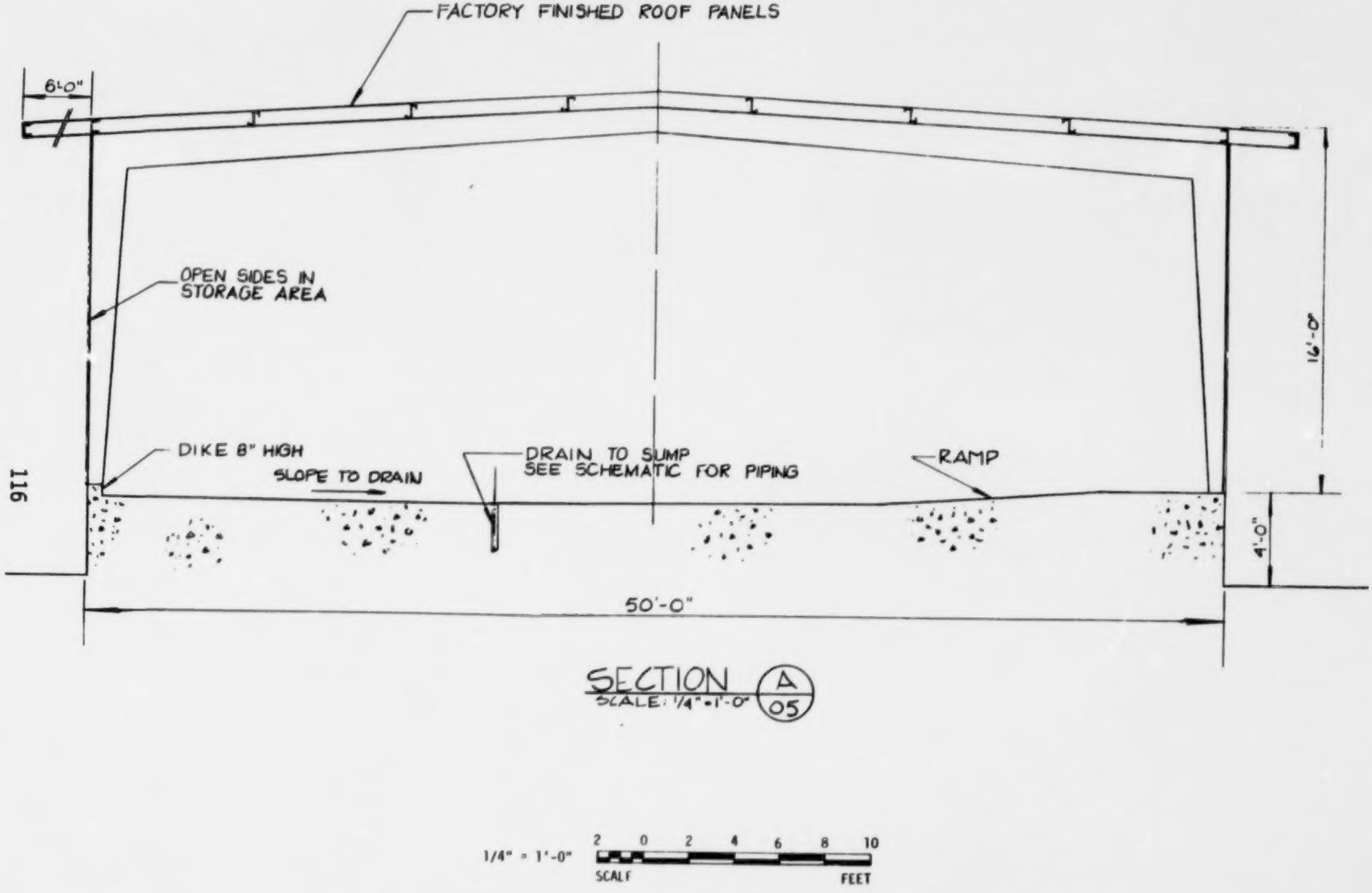

FACTORY FINISHED ROOF PANELS
6'-0"
OPEN SIDES IN STORAGE AREA
16'-0"
DIKE 8" HIGH
SLOPE TO DRAIN
DRAIN TO SUMP SEE SCHEMATIC FOR PIPING
RAMP
4'-0"
50'-0"
SECTION A 05
SCALE: 1/4" = 1'-0"
1/4" = 1'-0"
2 0 2 4 6 8 10
SCALE
FEET

Figure 27. Shore Based Support Building Section

A roofed but unenclosed storage area is incorporated at one end of the structure. This storage area has a concrete floor surface and is surrounded with an 8-inch high concrete curb or dike for containment of possible accidental spills. The diked area is provided with floor drains which are piped to an underground catchment sump for containment of spills and washdown, testing, and either disposal or drainage.

Adjoining the storage area is a truck loading dock capable of accommodating one truck of any size and type. Adjacent to the truck dock is a rail loading dock capable of receiving one rail car of any type now in common use. About 60 percent of this dock is roofed.

The enclosed habitable portion of the structure occupies 40 percent of the total structure floor area, or about 2,000 square feet. From outside the building, access to the interior is provided at two locations, as well as access to the hot water heater compartment, a storage closet and a mechanical closet. The first of these entrances opens into a secretarial and reception bay of 156 square feet. Access from this bay to two offices, of 90 square feet each, is provided. The second building entrance comes from the roofed storage area and incorporates an airlock for control of odors and noxious vapors from material being stored. Within the airlock is a two-leaf door (6-foot opening) to a receiving and storage area of 252 square feet.

Next to the receiving and storage area, and inside the airlock is the preparation area. It is accessed via a two-leaf door from the central corridor (6-foot opening) and by single-leaf door from the receiving and storage area on one side and the laboratory on the other. The preparation area is 306 square feet in area and is used for preparing samples of wastes for analysis in the laboratory. These samples, which will be taken at the site where the waste material was packaged and sealed, will be used to determine the suitability of the waste for incineration and the processing and temperatures necessary to incinerate it properly.

The analysis is performed in the 306 square foot laboratory. The laboratory is accessed via single-leaf door from the preparation area or by a two-leaf door (6-foot opening) from the central corridor.

Across the corridor, near the entrance to the air lock, are doors leading to the men's and women's toilet rooms. In addition to toilet facilities and lavatories, the men's toilet contains a shower stall and dressing area.

The habitable portion of the building will have, in addition to local laboratory and toilet ventilation, an Environmental Control System (ECS) incorporating air conditioning for warm weather and electric heating for cold weather. For detailed requirements and calculations concerning the ECS see Section 6.3.4. ECS equipment will be a package unit located on the building roof.

Exterior walls and roof of the habitable area will incorporate thermal insulation providing an insulating value of R19 for the roof (equivalent to 6 inches of batt insulation) and R11 for the walls (equivalent to 4 inches of batt insulation).

Only one structural consideration of a major nature need be addressed in the design at this stage. Since the area generally under consideration for the site all lies in an area where potential damage from seismic activity is not a factor (refer to Section 23, Figure 1 of the 1976 Edition, Uniform Building Code), only resistance to wind loads need be addressed. The whole Gulf Coast area experiences periodic hurricane-force winds which, considering this structure specifically, will require it to be engineered to resist winds of this magnitude. This required wind loading is possible to obtain in pre-engineered buildings from nationally distributed firms, although the building perimeter between the covered and unroofed rail dock (where no diagonal bracing rods can be used) may necessitate some special engineering and added expense.

6.3.3 Potable Water System

Potable water will be supplied by the local utility company. Since the water service line will also be required to serve the various fire protection locations, a 6-inch main at a convenient location to supply potable water to the support building will be required at the site.

6.3.4 Environmental Control System

The support building will require space heating and air-conditioning. This will be accomplished by a packaged environmental control unit located on the structure roof. This unit will incorporate a refrigerant system for air-conditioning and an electrical resistance heater for cold weather heating.

The general design parameters used are as follows:

- Maximum summer design temperature = 93°F
- Probable design wind velocity = 110 mph (local building code requirement)
- Average wind velocity = 12 mph
- Interior temperature, summer = 78°F at maximum 60 percent relative humidity
- Interior temperature, winter = 65°F
- Occupancy of building, 8 persons normal, 10 persons maximum
- Laboratory with fume hood exhausting at 150 cfm.

The environmental control system resulting from these parameters will have the following characteristics:

- Supply air flow = 1,320 cfm
- Return air flow = 1,070 cfm
- Required normal cooling capacity, total of latent and sensible heat = 44,400 Btu/hr
- Required capacity of electrical resistance heater (winter heating) = 9 kW.

6.3.5 Facility Power

The facility will utilize commercial electric power from the local public utility. The total connected load for the facility will be approximately 35 kVA, including lighting, convenience receptacles, sump pump and environmental control system loads.

Main service will be 480/277 volt through a main breaker to a distribution panelboard equipped with circuit breakers. This panel supplies all the required 480 or 277 volt power for the site. This panel also feeds a 480-120/208 transformer which, through a second panel, supplies the site's 120 volt loads. No on site transformer station will be required.

6.3.6 Facility Fuel Gas

Fuel gas service from the local public utility will be required at the facility as fuel for the hot water heater and in the laboratory. The supply for a 40 gallon hot water heater and provision for five bunsen burner outlets will require approximately 59 cubic feet of fuel gas per hour maximum. This will, assuming the gas meter to be placed near the property line, require a 3/4-inch delivery line to the support building.

6.3.7 Sewage System

The sewage system at this site is connected to the local municipal sewage system. Only drains from the two toilet rooms and the laboratory are connected to the building sewer, which is sized at 3 inches in diameter. All other waste generated on site is separately contained for disposal by other means. None of this waste will be handled by the site sewage system.

6.3.8 Storage Areas

Two storage areas are provided as part of the facility, one occupying about one-half of the support building and an open, diked area.

The first of these, that in the support building, comprises 1,660 square feet and is intended for use in storing waste material in drums, normally of 55 gallon capacity each. This area is roofed but has no walls on three sides in order to insure adequate ventilation. Within this area, which is surrounded by an 8-inch curb or dike to retain spills, are three floor drains piped to an underground sump tank near the building. Any spills can be readily flushed away and pumped into new containers from the sump tank.

The second storage area is open and unroofed but is surrounded with a dike (Figure 25). This dike is designed to retain 18 inches of fluid with a 1-foot freeboard. The interior of this storage area will be surfaced with reinforced concrete, partly as a traffic surface and partly as a leakproofing measure. The dike is provided with a sump and pipe connection for pumping spilled fluid into new containers in the event of a spill, or for discharging rainwater to a ditch, after testing assures that it is not polluted.

6.3.9 Dock Facilities

It is anticipated that dockage facilities will not be purchased but will be leased or rented. Such facilities should be in reasonable proximity to the site proper but do not need to be immediately adjacent; moderate haul distances could be tolerated if not through populated areas. The dock will be required to have space for laying alongside at least one vessel 200 feet long and should be capable of accommodating a minimum of a 15-foot draft. It should be located in a well-protected harbor area.

Cargos may consist of both 55 gallon drums and containers. Containers will probably not exceed 2,000 pounds gross weight. Vessels will generally not be equipped for self-loading/unloading, so appropriate mobile material handling equipment (cranes or forklifts) should be available. Because of hazards to personnel handling these cargos of toxic materials, first-aid and deluge shower facilities should be present.

6.3.10 Facilities Safety Systems

In order to promote safe operations at the facility, a number of safety systems will be required. Provisions for fire extinguishing, possible protection against special hazards and first aid will all be discussed in this section. Communications would logically be discussed here but must be deferred until an actual shore base site is selected, the potential distance between shore and off-shore locations being considerable.

Fire protection provisions will include overhead sprinklers, deluge showers, hose racks, portable extinguishers and hydrants. Sprinklers will be required to provide coverage for all roofed areas in the support building, including both enclosed habitable areas and the outdoor covered storage area.

Deluge showers for washing chemical spills off personnel will be located as follows:

- One in the laboratory
- One in the covered storage area
- Two in the open storage area, located at diagonally opposite corners
- Two at the dockside area.

Hose racks, each equipped with 100 feet of 1-1/2 inch hose will be located at each deluge shower in the open storage area. Both hydrants and portable extinguishers will be required on the facility and will be located according to local ordinances.

Personnel protective equipment will include respirators and self-contained breathing apparatus for emergencies. Protective clothing will be routinely worn when handling hazardous materials.

First aid supplies will be required at the facility as will personnel with the proper training to administer such help. First aid supplies in appropriate containers, located in prominently visible locations, should be placed in the laboratory, the covered storage area and the open storage area. Members of the staff, provided with the proper training in emergency first aid, will be essential to the proper administration of such first aid. One such person, at minimum, should be on the premises whenever the facility is in operation.

6.3.11 Support Building Sump

In order to contain and repackage any spills occurring in the covered storage area at the support building, a system of three floor drains piped to an underground catchment has been included. The catchment will consist of a 3,000 gallon tank which will be buried near the building. Further information will be needed concerning the nature of the waste materials to be handled in order to specify the materials used in the construction of this sump tank, but it is probable that either steel or fiberglass will be used. It will be necessary that the sump tank be vented. An electrically powered pump (1/2 horsepower) located above the tank in a small weather-protection structure will be used to empty the contents of the tank into new containers.

6.3.12 Structural Considerations

Other than general supposition based upon present information (refer to Section 6.3.2) no discussion in depth of structural considerations is presently possible.

Many municipalities in the Gulf Coast region in the general area near the offshore platform location use the South-East Region Uniform Building Code (UBC). Information from authorities in the area indicates that, at the present time, the wind velocity used for structural design in these coastal areas is 110 mph, because the area is subject to hurricanes. (Refer to Appendix A, "Preliminary Structural Loading Criteria.")

Based upon a probable effective height above grade of the support building of 20 feet, formulation in the UBC gives a design wind pressure at 110 mph of 27.59 pounds per square foot. This is within the capabilities of pre-engineered steel buildings. The actual structural design of this type of building is customarily done by the manufacturer, based on parameters established by the customer, his engineers and local building authorities.

Another factor affecting structural design will be the bearing capacity of the soil at the site. Pre-engineered buildings of the type contemplated are supported by column footings carrying the ends of each rigid frame. Assuming that a very low soil bearing value of, for example, 1000 pounds per square foot is encountered, the resulting footings would be about 3 feet square, assuming characteristics for the building that are typical for most manufacturers.

Floor line loadings within the building will vary from 50 pounds per square foot for the office areas to a maximum of 250 pounds per square foot for the covered storage area. Loadings for the open storage area will be of a similar magnitude. These loadings can be readily supported even by soil of low bearing value, and such load values are consistent with provisions of the UBC.

Roads and parking areas on the site, as well as any bridge structures and ramps, must be designed to carry the heavy loadings of trucks and other vehicles which will traverse them. A common method of specifying such anticipated loadings is the Criteria for Bridge Loading formulated by the American Association of State Highway Officials (AASHO). Using the AASHO system of designation, an H-20 loading (20-ton truck) should be used.

The design of earth dikes and fill is closely related to the soil mechanics of the site. In the absence of specific information about a real site, detailed discussion of these areas is not possible.

6.4 MULTIMODAL CONTAINERS

The objective of this part of the study was to conceptually design and cost a multimodal container for hazardous wastes. This requires consideration of the wastes to be moved, equipment available for transporting, and container technology. Analysis of the problem depends on clearly stating the requirements of the system. These become the criteria for choosing between possible solutions. After this is done, various alternative solutions are proposed, their relative ability to meet the requirements is weighed, and the most effective system is chosen. This basic method has been used to perform this part of the study. It should be noted that in deriving the size of the platform storage area (Section 6.1.7), 55 gallon drums were used as the standard container. This choice had no bearing on the container study, because the drums were used only as a reasonable assumption in order to arrive at the needed storage space. Storage space will be adequate no matter which container is chosen, because all of the candidate containers are more efficient in space utilization than the drums.

6.4.1 Analysis

The intent behind the use of a multimodal container is directly concerned with safety and, to a lesser extent, efficiency. Safety considerations are paramount since hazardous materials are the only items that are intended to be shipped to the incinerator. Because of the danger to everyone in close proximity to the containers throughout the shipping cycle, it is important that the integrity of the container be unbroken.

The second consideration, efficiency, is concerned with the ability to move the container freely between different modes of transport – ship, truck, or rail. (Hence the term "multi" or "intermodal" container.) This interchangeability is very desirable because the possible sources of hazardous materials can be anywhere in the Continental U.S.

To load material at a remote site, move it over rail and highway, and eventually load it aborad ship for the incinerator necessitates a container that is capable of safe, routine handling at every transfer point. The International Standards Organization (I.S.O.) container became an obvious contender for this job since it was designed specifically for intermodal use. As the study progressed, it became evident that there could be problems in handling large (8' x 8' x 20' is the common size) I.S.O. containers at the platform, in addition to the more serious handling problems at a "nonpredetermined" spill site. This, and other logistics problems connected with the facilities material handling interfaces, caused a wider evaluation of available containers.

6.4.1.1 Requirements and Constraints

Requirements for an intermodal container for the purpose of this study are as follows:

1) Design – Container must hold one, or all, of the three types of waste identified for this project without leaking under normal transport conditions.
2) Interchangeability – Efficient transfer of containers from one mode to another by use of crane, forklift, conveyor, or other means.
3) Storage – Capable of efficient storage in minimum space through stacking and minimum headspace.
4) Strength – Withstand shock of transport and the effects of corrosive contents and a salt air environment.
5) Decontamination – Ability to withstand repeated decontamination by rinsing with diesel fuel.
6) Efficiency – Low tare weight/gross weight ratio and a size suited to the majority of incidents that can be expected.
7) Availability – Readily available from U.S. suppliers for purchase or lease.

8. Maintainability — Repairable by common methods and routine workmanship.

9. Cost — Competing containers must be cost-effective.

10. Legality — Containers must meet the regulations of the appropriate authorities.

There are no constraints on the container. There are constraints on the operation of the total system which have some effect on the choice of a specific type of container. These constraints are:

- No air transport is to be used.
- No gases are to be shipped.

6.4.1.2 Assumptions

For the purpose of this study the following assumptions have been established:

- Multimodal containers will be considered as the primary means of transport; other containers will only be listed as options.
- Hazardous material will be stored at both the shore station and ocean platform.
- Material will not be transferred from one container to another at the shore station.
- Containers must be decontaminated on the ocean platform before return to shore.
- Three substances are to be moved: liquids, dry granular solids, and items similar to debris from a landfill.

6.4.1.3 Discussion of Proposed Alternates

Each of the proposed container types is discussed in detail below:

Dry Bulk Material Container (BMC)

These are comparatively large, sealed, metal containers which can be used with any type of transport mode. Efficiency in storage and handling is a function of individual design. The specific design prescribed here is very suitable, however, there is no recommendation of this specific manufacturer impled; one design has been chosen as being typical of all those available (Figure 28).

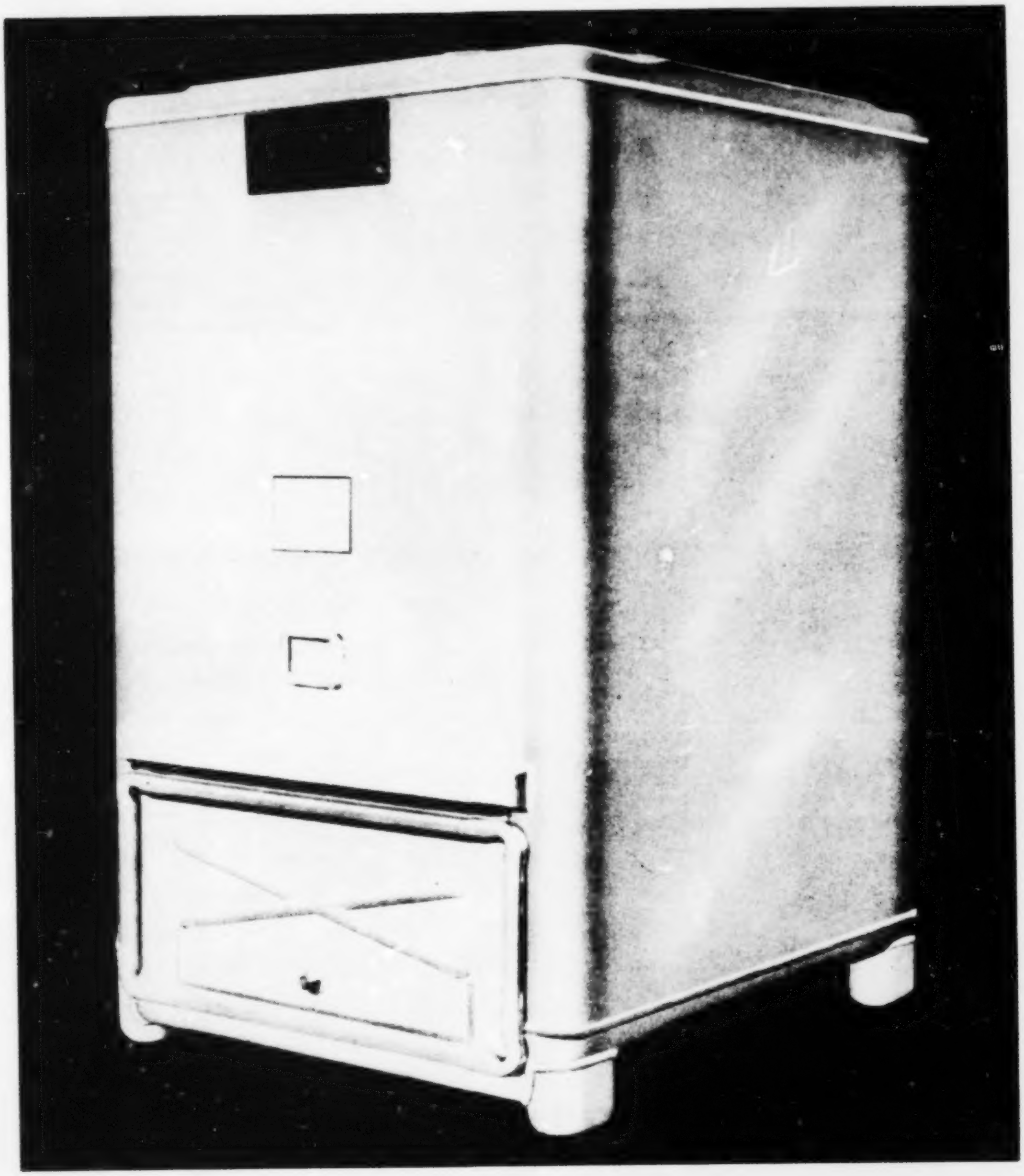


Figure 28. Dry Bulk Material Container

One manufacturer's container has a capacity of 90 cubic feet with dimensions of 42" x 48" x 83". Tare weight is 604 pounds for the steel container. Stainless steel and aluminum are also available. There are several load/unload options including side and bottom opening doors. Stacking and handling is facilitated by designing stacking lugs and supports which allow forklift handling.

Provision for crane handling is taken care of by welding on lifting lugs or using special spreader bars. Loading of the BMC is through the top; unloading can be by several means including pneumatic conveying. A special tilting frame that rotates the BMC at a controlled discharge rate is recommended (Figure 29).

Another feature of the dry BMC is that it can be converted to carrying liquids by inserting a polyethylene lining. This is a convenient feature for adapting the BMC if there is an emergency requirement.

Liquid BMC

This container is similar in most respects to the dry BMC with the obvious differences in the valves and leakproof construction. The proposed predesigned, "off-the-shelf" container has a capacity of 549 gallons with dimensions of 42" x 48" x 70-1/2". This container is also available in steel, stainless steel, or aluminum.

All of the previous remarks on storage and handling apply to this BMC. It is important to note that an advantage in storage space utilization is realized because these containers are not cylindrical as most other containers are.

Metal Fifty-Five Gallon Drums

The commonly used "55 gallon drums" is one of the cruder froms of multimodal containers. It can be used in all forms of transport and is reasonably easy to handle. The great advantage of the metal drum is in its ubiquity and low cost. For use in this type of program the drum should meet at least the D.O.T. 17C specifications.

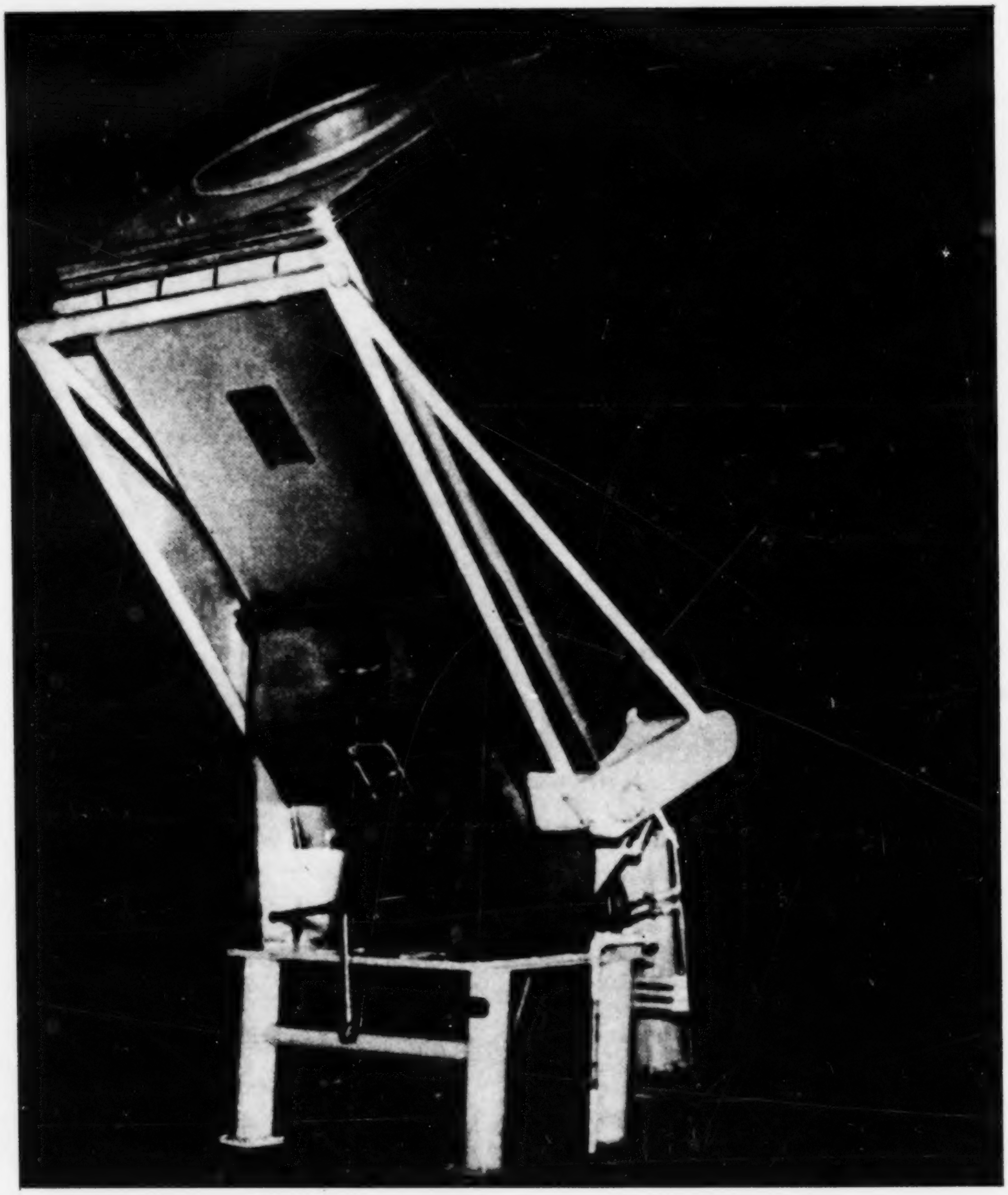


Figure 29. BMC Unloading Device

Two reasons for considering these drums are: (1) many chemicals are now packaged in these drums and they should not be repackaged before incineration, and (2) the cost of the drums may be low enough that it is feasible to destroy the drums after one use rather than decontaminating and returning them.

Flexible Rubberized Tanks

A collapsible tank that can be rolled up and easily moved when empty has many advantages for liquid shipments. These have been developed and used as storage tanks for gasoline and other products. The specific tanks of interest range in capacity from 1,100 to 5,100 gallons. When filled, they fit on standard truck/trailer equipment. By strapping them to pallets they can be put on board ships and moved to the platform. Normal loading and unloading equipment is used (Figure 30).

I.S.O. Containers

These are the intermodal containers of regular commerce which meet the I.S.O. specifications. The sizes of interest are 8' x 8' x 10' and 20' long. Materials for containers include steel, aluminum, and fiberglass. Capacities are 10 and 20 tons, respectively. These containers are not in their normal configuration directly usable for the purpose. This is because they can only be used to hold smaller containers which are suitable for the liquid or solid wastes. This consolidation effect is useful at times, but is inefficient in space utilization and requires a much larger crane to handle the maximum tonnage. The types of containers that can be used to best advantage are those special designs that are made to carry liquids or bulk solids. These have all the advantages of the intermodal feature plus being able to handle the hazardous wastes securely. They can also be decontaminated, which is not the case with a normal I.S.O. container.

I.S.O. containers are available new or used. The 20-foot long model is the most popular; the 10-foot model is rare although it can be procured on special order or used. The liquid tank model is more expensive than a normal model, as is a bulk solids model. It is possible to install a tank (dry or solid) in a used container at a significant savings. There would be design charges involved in this option since this type of work is not being performed regularly by the large suppliers.

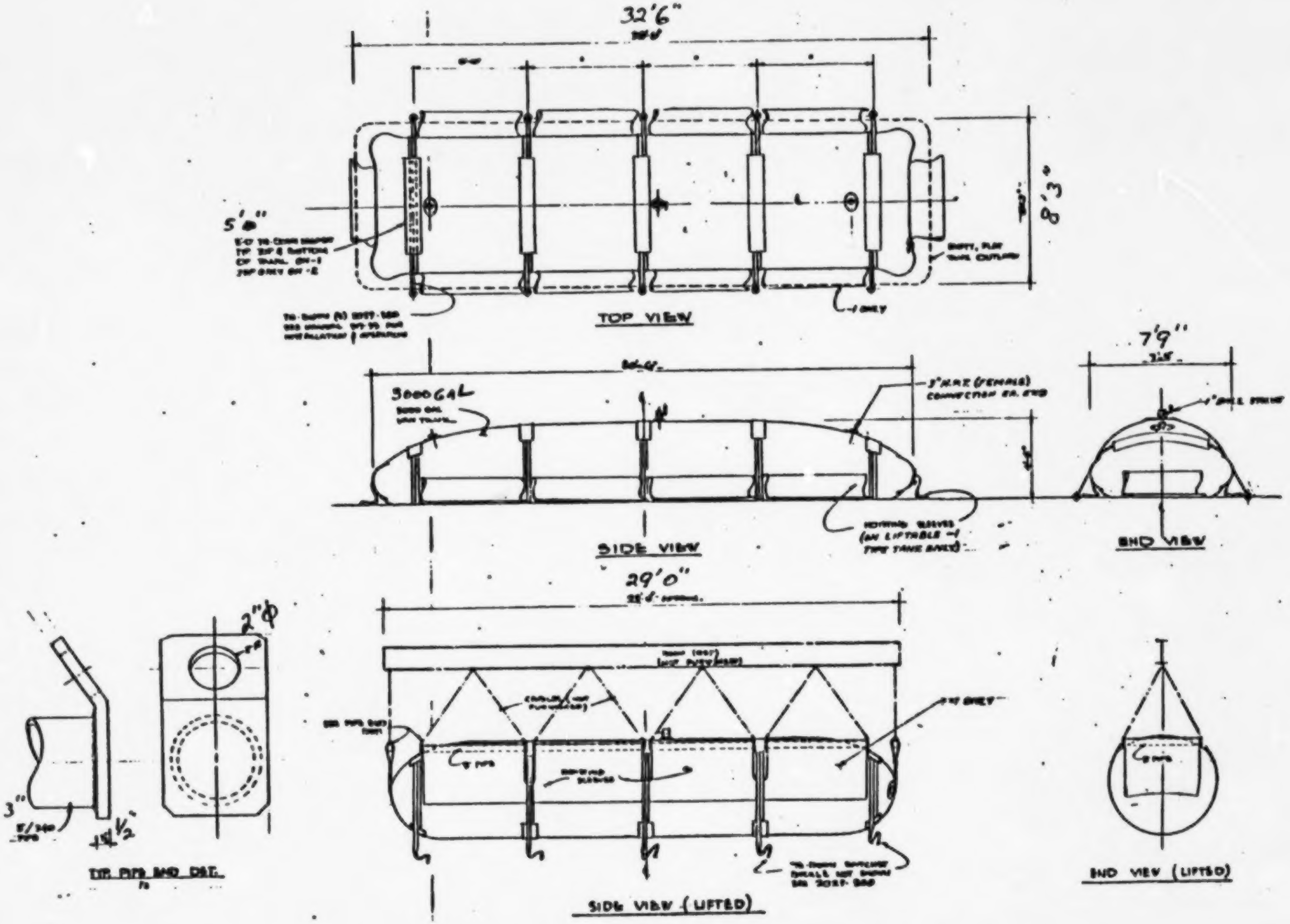

32'6"
8'3"
5'0"
TOP VIEW
7'9"
3000 GAL
SIDE VIEW
END VIEW
29'0"
SIDE VIEW (LIFTED)
END VIEW (LIFTED)
2"Φ
3"
1/2"
TYP. PIPE END DET.

Figure 30. Flexible Rubberized Storage Tank

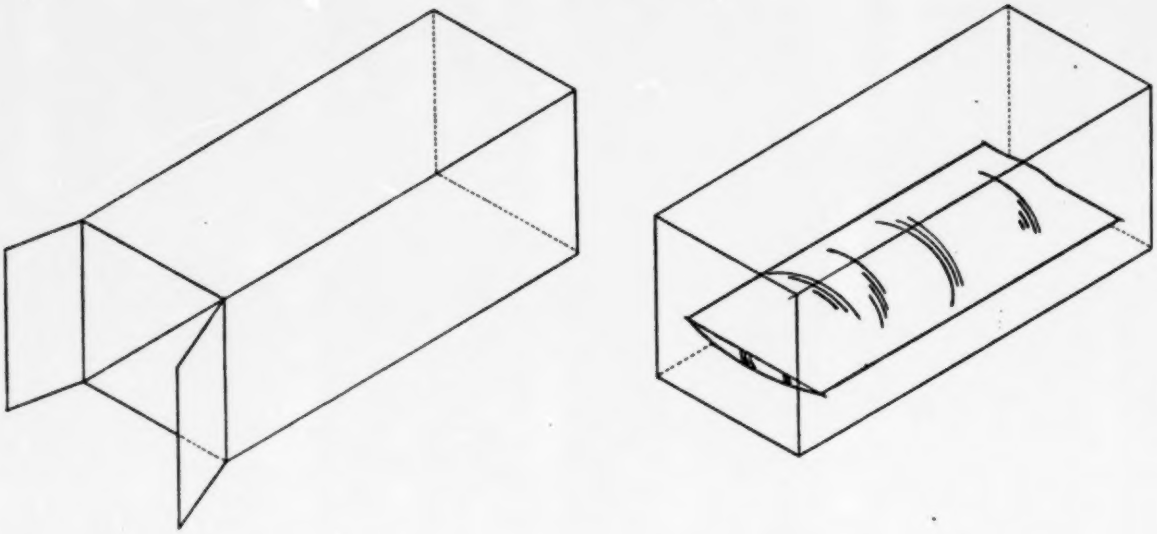
Containers are very efficient in terms of storage since they are capable of being stacked six high. They require special handling fixtures and large capacity cranes. However, the forklifts that are large enough to handle containers are far too large and heavy to be used on a platform. It is usually necessary to have some handling equipment available for loading and unloading the container through its end doors. For this reason it is not really efficient to use a container to move 55 gallon drums. The handling time to load and unload the container is probably equivalent to the time used in handling the individual drums. Figure 31 shows various forms of the standard I.S.O. container.

Table 17 is a comparison matrix which demonstrates the relative merits of the proposed alternate containers.

TABLE 17. COMPARISON MATRIX OF CONTAINERS VS. REQUIREMENTS

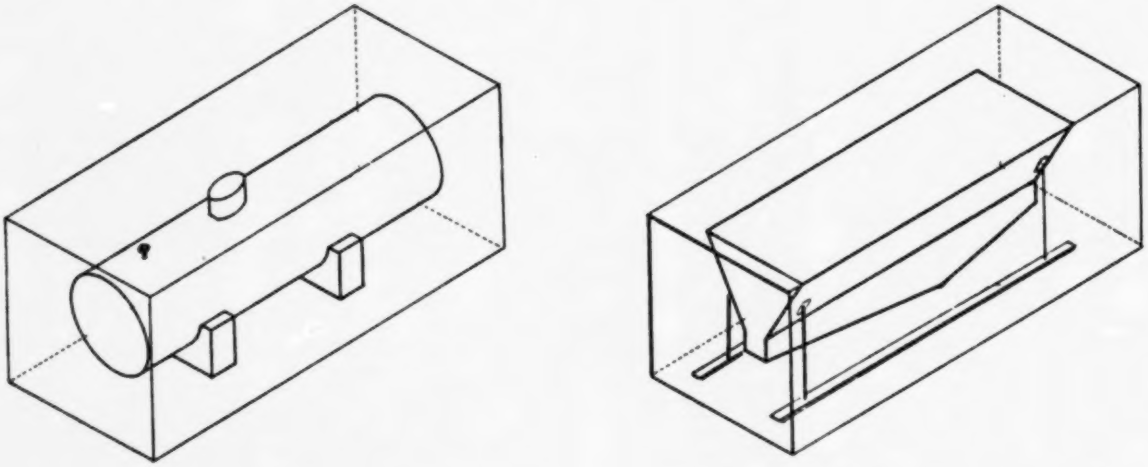
	BMC	Drum	Flexible Tank	I.S.O. Container	I.S.O. Container Special Design
Design	E	P	P	P	E
Interchangeability	E	G	G	E	E
Storage	G	P	G	G	E
Strength	E	G	G	E	E
Decontamination	E	N	P	P	G
Efficiency	E	E	E	G	P
Availability	E	E	G	E	P
Maintainability	E	E	G	G	G
Cost	E	E	E	G	P
Legality	E	G	G	E	E

E = Excellent G = Good P = Poor N = Not Applicable



STANDARD 8' X 8' X 20' I.S.O. CONTAINER

FLEXIBLE RUBBERIZED TANK
MOUNTED IN I.S.O. CONTAINER



REMOVABLE LIQUID TANK
MOUNTED IN I.S.O. CONTAINER

REMOVABLE DRY BULK CONTAINER
MOUNTED IN I.S.O. CONTAINER

Figure 31. Special Designs Utilizing Basic I.S.O. Containers as Transport Device

6.4.2 Cost

Cost estimates are based on current quotations from suppliers or engineering estimates if new designs are required. The direct comparison between containers based on a dollar per cubic foot of volume is shown in Table 18; however, too much emphasis should not be placed on this figure because numerous other factors govern, as discussed in Section 6.4.1.

TABLE 18. CONTAINER COST ESTIMATE SUMMARY

Container	Capacity	Cost	$/c.f.
1. Dry BMC	(90 cubic feet)	$ 790	$ 8.75
2. Liquid BMC	(549 gallons)	$ 700	9.60
3. Metal Drums	(55 gallons)	$ 22	2.97
4. Flexible Tanks	(2,100 gallons)	$3,500	12.46
5. I.S.O. Container	8' x 8' x 20' New	$8,200	10.68*
	8' x 8' x 20' Used	$1,400	1.82*

*Assuming 60 percent Loading Efficiency.

6.4.3 Recommendations

No single container can efficiently perform all of the tasks required for this project. There are also exceptional cases which can occur and which the system will accept with some loss of efficiency. Keeping these qualifications in mind, the recommended standard containers are:

1) Dry bulk material containers (BMC) at 90 cubit feet capacity
2) Liquid BMC at 549 gallon capacity

Optional alternate containers are:

1) Standard metal tight-head drums at 55 gallon capacity.
2) Collapsible, rubberized containers at 1,100 to 6,000 gallon capacity.
3) Standard and special I.S.O. containers in sizes 8' x 8' x 20' or 8' x 8' x 10' at 20 ton and 10 ton capacities.

6.4.4 Description of the Proposed System

The container system consists of 60 dry BMC's and 350 liquid BMC's. Table 19 is a description of these required quantities. One tilt fixture is required for feeding the incinerator through the shredder. The liquid wastes are fed by a pump and manifold system. They can also be fed by gravity in case of an emergency loss of power.

TABLE 19. COMPUTATION OF NUMBER OF BMC's REQUIRED

1.	Pounds of dry waste to be incinerated in 2 weeks — 1,100 lb/hr x 8 x 10	= 88,000 lb
	Convert to cubic feet at 50 lb/cf	= 1,760 cf
	Multiply by 3 to allow for filling the system with containers	= 5,280 cf
	Number of BMC's at 90 cf each	= 59, use 60
2.	Pounds of liquid waste to be incinerated in 2 weeks — 6,600 x 8 x 10	= 528,000 lb
	Convert to cubic feet at 62 lb/cf (X3)	= 25,548 cf
	Convert to gallons at 7.48 gallons/cf	= 191,000 gallons
	Number of BMC's at 549 gallons each	= 348, use 350

Handling devices to interface with BMC's are routine: forklifts transfer them on the platform and during transit. Forklifts of 7,500 to 10,000 pound capacity are adequate. Crane attachments are made by lugs designed for the purpose. Stacking two or three high is a design feature.

By referring to the hazardous material flow diagrams, Figures 8 through 11, it is possible to visualize how the BMC is to be used in the system. It is small enough to be moved to almost any spill location by normal truck equipment. It can be easily loaded with either dry or liquid wastes. Once loaded, it can be put on any standard truck or railcar and tied down. Transfer to sea transport is performed by crane or forklift. At no time is the container opened during transit.

To consider how the optional containers might be used, it is necessary to think of some of the usual situations that might be faced in the operation of the incinerator. The 55 gallon drum is very likely to be used in cases where there are large inventories of hazardous chemicals packaged in these drums. In this case, it might be unwise to try to unload the drums anywhere except at the platform. Because of the desire to prevent these drums from being reused, it is planned to shred and incinerate the lighter ones and to crush the heavier ones. Equipment has been provided on the ocean platform for this purpose.

Another situation that may occur could be a spill at a remote location that requires a large quantity of liquid to be picked up quickly. An empty collapsible tank can easily be moved into the area and filled. This tank can then be transported to the platform. It would be advisable to protect the bag with a rigid cover to prevent puncture. (One of these tanks has been proposed as a means of containing spills on the platform.)

The I.S.O. containers, particularly the special designs, are excellent choices as a basic system except for the costs. They become increasingly more effective as the amount of materials to be handled increases. If this platform were to become a "production" facility and handle, for example, the routine clean-up of large landfills, it might become cost effective to use these larger capacity containers.

6.5 COST ANALYSIS

Cost estimates for the support facilities are summarized in Table 20. Detailed breakdown of the four categories; on shore, offshore platform, containers, and miscellaneous, are contained in Tables 20 through 24. The detailed analysis and sources of all estimating data are given in Appendix C. This section describes how each major category was costed and the variables that affect the accuracy of the estimates.

The general method of approach for estimating construction costs was to use the approved design concepts as a basis for the normal costing techniques. Facilities work is subdivided by the usual categories of site preparation, foundations, electrical, mechanical, and so on. This approach is, of course, completely inappropriate for the offshore platform where

TABLE 20. SUMMARY OF FACILITIES COST ESTIMATE

A.	Onshore Station	$ 647,700
B.	Platform	2,095,900
C.	Containers	276,200
D.	Miscellaneous Equipment	43,400
E.	Transportation*	257,800
	Total	$3,321,000

*Transportation costs are for construction phase only. See Table 24. (Assuming Option A.)

the "foundation" is an existing structure of unknown condition. For this reason a different procedure was used which is described below. The container and miscellaneous categories are almost entirely purchased items so they were based on actual quotes. All costs are given in October 1979 dollars and markups, contingencies, and fees are estimates.

6.5.1 Onshore Base

This is a routine estimate following normal procedures. Labor and material costs are derived from the latest (1979) copy of Means Estimating Manual. All costs were adjusted for the Mobile, Alabama, area which is less costly than the national average. A caution that must be applied to this estimate is that it is based on a concept which has no firm location at this time. This means that the entire facility is ideal in that it is rectangular in plan, close to all required utilities, and presents no location problems. Because this estimate is based on conceptual designs, it constitutes an ROM (Rough Order of Magnitude) and can be considered to be approximately ±30 percent accurate. However, since the location of this facility cannot be determined at this time, this is an adequate estimate for planning purposes. No land or acquisition costs were included in the estimate, but leasing costs were estimated. Table 21 presents details of the onshore facility cost estimate.

TABLE 21. COST ESTIMATE OF ONSHORE FACILITIES

Details	
Onshore Station	
Site Preparation - 3.7 acres	$ 5,900
Paving - A.C.	14,100
Concrete	28,100
Railroad Siding - 210 feet	8,500
Fence - 1,600 feet	14,700
Building - 5,000 S.F.	125,000
HVAC*	5,700
Electrical	35,000
Subsystems	9,700
Laboratory Equipment	200,000
Total	$446,700
General Contractor's Overhead and Profit (25%), Contingency (10%) and Engineering (10%)	201,000
	$647,700

*Heating, ventilating and air conditioning

6.5.2 Offshore Platform

This facility presents several severe problems in estimating which are reflected in uncertainties in the costing. The problems are due to: (1) offshore location, (2) uncertain structural conditions and, (3) possible use of alternate construction techniques.

Location. There are allowances that must be made for working offshore on a platform due to the support costs, i.e., food, lodging and transport for workers. There may be wage increases and insurance costs for this type of work. Delays are inherent in the situation because of weather, shipping, shortages, and general conditions. Our allowance for all of this was to double the labor costs for all of the work performed on the platform. The basic hourly estimates were assumed to be for work performed on land in the Mobile, Alabama, area.

Structural. For the purpose of this report it was necessary to define a very distinct interface between the supporting structure and the facilities being estimated. The most obvious interface is the deck. With a few important exceptions it can be assumed that everything from the deck up is to be included in this estimate and the structure from the deck down is to be estimated by others. One exception to this rule is the crane support which is discussed below. The facilities to be installed on the deck are: the incinerator with its controls and auxiliary equipment, housing, cranes, and all of the subsystems required to support and maintain them. The installation costs for the incinerator, housing and crane are subject to more uncertainty. They are covered in the following section.

Alternate Construction Techniques. Each of these three major items can be installed in at least two different ways. The article can be completed on shore and delivered to the platform (the "one-piece" method), or it can be shipped out disassembled and built up on the platform. These can be crucial decisions due to the costs of handling plus the larger labor costs of assembling similar items under difficult conditions. Some considerations are:

- Incinerator. If this is built on shore, it will weigh approximately 100 tons. The handling problem, however, has to do with the brickwork because it is likely to be damaged in shipment. A decision has been made to ship the incinerator in pieces and assemble it on the platform.
- Crane. The crane has been the subject of considerable analysis during this study. Briefly, there is a method whereby the crane, or cranes, can be assembled in advance on the platform and then used to assemble all the other equipment. This avoids the cost of a large derrick barge which is required to install the large pieces of equipment. On the other hand, there is the increased cost of supporting laborers on the platform for the length of time required to assemble the equipment. The analysis slightly favors the piecemeal approach. The largest imponderable is the weather. If a derrick barge cannot be used due to weather while under contract, the standby charge approximates $60,000 per day. This is difficult to insure against. Crane costs also vary considerably. Quotes range from $300,000 to $800,000, which is an uncomfortable range for machinery that is supposed to

be equivalent in capacity. A method of using a smaller crane to erect a larger one which then handles all the remaining work is the recommended method. Costs on this approach have been used in the analysis.

- Housing. The housing system proposed is a complete two-story unit, with helipad, assembled and delivered on the dock at Houston. This implies a large crane that can handle a minimum 50 ton lift. If a boom crane is used on the platform, it has to be located close to the house foundation since the boom radius cannot be too great. The implications for platform design are obvious. It is certainly possible to ship the housing in three pieces if the cost penalty for assembly on the platform is accepted. The estimate is based on the one-piece shipment.

Details of the offshore facilities cost estimate are presented in Table 22.

TABLE 22. COST ESTIMATE OF OFFSHORE FACILITIES

Details	
Platform	
Building, Living Quarters -3330 S.F. at $185/S.F.	$ 616,000
Control Center - 225 S.F. at $50/S.F.	11,300
Helipad	100,000
Mechanical and Electrical Subsystems	636,500
Crane (Boom Type, Capacity 10 tons at 100 feet)	460,000*
Structural Work	12,500
	$1,836,300
Overhead, Profit, Contingency and Engineering on Subsystems and Structural Only	259,600
Total	$2,095,900

Note: Labor rates from means, 1979 Edition, adjusted for Mobile, Alabama, and increased to reflect offshore working conditions. (See discussion.)

*Crane costs can vary from $460,000 to $875,000 depending on the supplier and the installation method chosen. Structural work includes: Dike and foundations for crane, housing, and incinerator from the deck interface up. No work below the deck is included.

6.5.3 Containers

Quotes for this equipment were obtained from the manufacturer because this is readily available off-the-shelf material. Numerous other container types were investigated and costed as part of this task. All of this work has been recorded in the appropriate sections of the report. The quantities, and the rationale for arriving at them, are explained in the previous section. Table 23 presents details of the container cost estimate.

6.5.4 Miscellaneous Equipment and Transportation

Under miscellaneous equipment are the various items that are not included in the other categories, such as drum crushers and forklifts. Transportation charges refer only to the cost of shipping material from shore to the platform and is listed as a separate entry because of its importance to the project. For costing purposes the size of barge required to haul all of the platform facilities in one load was estimated and a quote for moving this quantity was obtained. Depending on the mode of construction employed, the actual shipment of material may be in smaller lots consigned to workboats. If this should be the case, the total cost would still be comparable to the estimate in this report (Table 24).

6.5.5 Operational Costs

Operational costs for the onshore facility include labor, supplies, utilities, maintenance, and depreciation of equipment and buildings. Preferably, an existing federal government facility, including a dock, will be available for the shore base. If this is not possible, land and dock facilities may be rented or leased. Because a specific area has not been identified, only rough estimates can be made of facility rental costs.

Estimated labor costs for operation of the onshore facility are based upon an 8-person staff, consisting of:

1 General Supervisor	Overall responsibility for facility operation, safety and personnel
2 Secretaries	1) General clerical and secretarial duties 2) Material control and analysis records

TABLE 23. COST ESTIMATE OF CONTAINERS

Details	
Containers	
Dry Materials:	
Tote Systems No. S-90 59 at $789 each	$ 46,600
Liquid Materials:	
Tote Systems No. S-549 350 at $656 each	229,600
Total	$276,200

TABLE 24. COST ESTIMATE OF MISCELLANEOUS EQUIPMENT AND TRANSPORTATION

Miscellaneous	
Drum Crusher	$ 8,600
Forklift	25,000
Container Discharge Equipment	5,800
Liquid Discharge Equipment	4,000
	$ 43,400
Transportation Charge	
Option A	$257,800
Option B	353,800

Note: Option A includes a second crane at $154,000.

Option B includes a derrick barge at a minimum charge of $250,000.

Sea transport is $103,800 in both cases.

1 Analytical Chemist	1) Determine methodology 2) Direct laboratory personnel
2 Laboratory Technicians	Perform required sample preparation and analysis
2 Forklift Operators	1) Unload and store waste shipments 2) Transfer wastes to dock

Approximate yearly labor costs for each of these job classifications, including overhead, administrative costs, and fee are:

General Supervisor	$79,000
Analytical Chemist	60,000
Laboratory Technician (2)	29,000
Forklift Operator (2)	26,000
Secretary (2)	24,000

Total labor costs for the onshore facility are estimated to be $297,000 annually.

Land rental costs for the Mobile, Alabama, area were investigated. Based upon a 10 to 20 year lease of approximately 4 acres of industrial land with access and intermittent use of a dock, an average cost of $\$.36/ft^2$ per year was determined. For the proposed 160,000 ft^2 onshore facility, the estimated land rental cost would be $57,600 per year.

In summary, the estimated yearly operational costs for 8 hours/day, 5 days/week operation of the onshore facility (except for insurance costs, if applicable, as discussed in Section 5.4.2) are as follows:

A.	Labor	8 person staff, 8 hrs/day, 5 days week	$297,000
B.	Maintenance	8% of installed equipment costs	20,000
C.	Depreciation	20% of installed equipment costs	50,100
		5% of building cost	6,300
D.	Land Lease	$\$.36/ft^2$ per year X 160,000 ft^2	57,600
Total yearly operating costs (without insurance costs)			$431,000

7. ENVIRONMENTAL ASSESSMENT

This portion of the feasibility study estimates the effects on air and water quality due to the incineration of hazardous wastes on the proposed offshore platform. The effects are considered both near the platform itself and at the nearest point on shore. The emissions considered are gaseous emissions from the incinerator stack (with or without an effluent scrubber), and water effluents injected into the ocean from the quench and scrubber operations. The possibility of added water pollution introduced by interaction of the atmospheric plume with the ocean surface, i.e., the touchdown effect, is also considered. The environmental effects of solid pollutants (such as ash) are considered in the development of alternative disposal actions as part of the system operation plan. Particulates which may be present in the gaseous emissions and in the liquid effluents are treated as a homogeneous part of the respective emissions for this feasibility study.

To estimate pollutant concentrations near the platform and on shore (100 km distant), a Gaussian dispersion analysis was used for both the gaseous plume and quench and scrubber liquids. The plume touchdown impacts were determined by a conservative semi-empirical analysis considering a unit volume ($1m^3$) of ocean traveling at a low rate underneath the centerline of the plume touchdown. Both "dry" deposition and "wet" (i.e., rain) conditions were considered.

The analysis examined the emission and dispersion of gaseous pollutants for 24 combinations of conditions for meteorological variables, incinerator stack and scrubber parameters, and ocean parameters. For the scrubber/quench effluent, eight combinations of effluent characteristics, seasonal parameters, and ocean current were examined. One of these condition sets was further varied among six effluent injection design selections. Plume touchdown was examined for overall worst case conditions: adverse meteorology and a current direction parallel to the wind direction. The pollutant concentrations for these analyses were normalized by expressing it per unit of mass flow of pollutant to provide generality.

For the purposes of this feasibility analysis, a typical liquid waste previously disposed of in an incinerator ship was selected. This "chemical manufacturing waste", CMW, is a mixture of chlorinated hydrocarbons containing 62.6 wt % chlorine, which is near the practical limit for undiluted incineration while maintaining a required combustion efficiency of 99.99%, and thus represents a worst case for the pollutant HCl. The CMW waste used also produced other pollutants, such as SO_2 and PCB, and thus provides a measure of the impact of these pollutants in quantities expected of similar wastes.

The actual impact estimates were based on three pollutant species being emitted: HCl, SO_2, and PCB. The waste feed rate selected was three metric tons per hour with 100% excess air. The pollutant concentrations were compared to permissible exposure standards from various government sources. Results for worst case conditions are as follows:

A. At 100 km, predicted worst case air quality concentrations are:

HCl	82.5 $\mu g/m^3$
SO_2	3.2 $\mu g/m^3$
PCB	0.0006 $\mu g/m^3$

These values indicate insignificant air quality impact.

B. At 24 m, for the scrubber/cooler effluent discharge, predicted worst case water quality concentrations are:

HCl	410 g/m^3
SO_2	20 g/m^3
PCB	.017 g/m^3

These values were found to be sensitive to outfall pipe design parameters such as effluent exit velocity, pipe length and angle of outfall exit, and hence, modifiable.

At plume touchdown predicted water quality concentrations (worst case, for 1 m^3 and contact time of 10^5 sec) are:

HCl	.58 g/m^3
SO_2	.023 g/m^3
PCB	.003 mg/m^3

The values for HCl and SO_2 concentrations are sufficiently low that pH or chlorinity will not be affected. The PCB value should be studied further, since it approaches the MATE value for PCB in an aqueous environment.

The results discussed in this section should be considered only rough estimates aimed at testing the feasibility of the incineration scheme. This is necessary because the analysis is severely limited by a paucity of information on meteorological and marine data for the site and by deficiencies in the analytical tools for treating a dispersion in the air of pollutants emitted over a body of water and for treating the impact of plume touchdown on water quality. While conclusions can be drawn from this analysis for worst case effects, better information must be obtained for achieving higher certainty of numerical results. At a minimum, a site survey for both meteorological and marine parameters should be carried out as part of the next phase in the development of the platform as an incineration facility. In addition, current research should be followed in ways to mathematically analyze dispersion over water and plume touchdown; more rigorous analysis should then be carried out to predict impacts via these mechanisms.

7.1 Air Quality Simulation Modeling

This section presents the results of the air quality simulation modeling, including a description of the Gaussian model, the input variables and a general overview of the Gulf Coast meteorology.* The philosphy behind the modeling effort was a parametric analysis, i.e., to evaluate the changes in pollutant concentration as a function of various meteorological and operating parameters. The calculations focused on assessing the impacts on the nearest point of land which is approximately 100 kilometers due north-northwest of the platform.

7.1.1 Results

Results** of the air quality simulation modeling for the scenarios depicted in Figure 32 are presented in Figures 33 through 40. In addition, the consequences of lowering the stack gas gemperature (from 300°C to 100°C) due to use of the scrubber is shown in Figure 41. Figures 33 through 41 plot normalized concentrations*, or concentration/emission rate = (X/Q), as a function of downwind distance. Numerical values of concentration (in micrograms/cubic meter) for a given pollutant species may be obtained by multiplying the normalized concentration by the emission rate (in grams/second) of the species. Emission rates used in the analysis for HCl, SO_2 and unburned PCB wastes are given in Section 7.1.5.2.

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*A comparison document to this report presents an environmental assessment of the marine environment potentially impacted by the proposed offshore incineration.

** The results show ground level plume centerline concentrations. Within the context of this report, ground level should be interpreted as "at the ocean surface."

At 100 kilometers downwind (the distance from the platform to the closest point of land), the average normalized concentration for the "D" class stability is 0.035 and ranges from 0.020 to 0.052.

The highest normalized concentration at 100 kilometers downwind is 0.152 and occurs for an "E" class stability, 15.24 meter stack height, 20°C and 29°C ambient temperature and a 3.1 meter/second wind speed (see Figures 37 and 38. The corresponding concentrations for HCl, SO_2 and unburned PCB wastes are:

HCl:	82.5 $\mu g/m^3$
SO_2:	3.2 $\mu g/m^3$
Unburned PCB:	0.0006 $\mu g/m^3$

Exposure standards set by various organizations are shown in Table 25. As can be seen, the highest simulated concentrations do not approach any of the standards. The concentrations of HCl, SO_2, and unburned PCB wastes are essentially representative of a 9-hour averaging time (100,000 meters to shore and a 3.1 meter/second wind results in 9 hours travel time for the plume to reach shore from the platform), assuming a constant wind speed and direction.** Standards for HCl and PCB are given in Table 25 for

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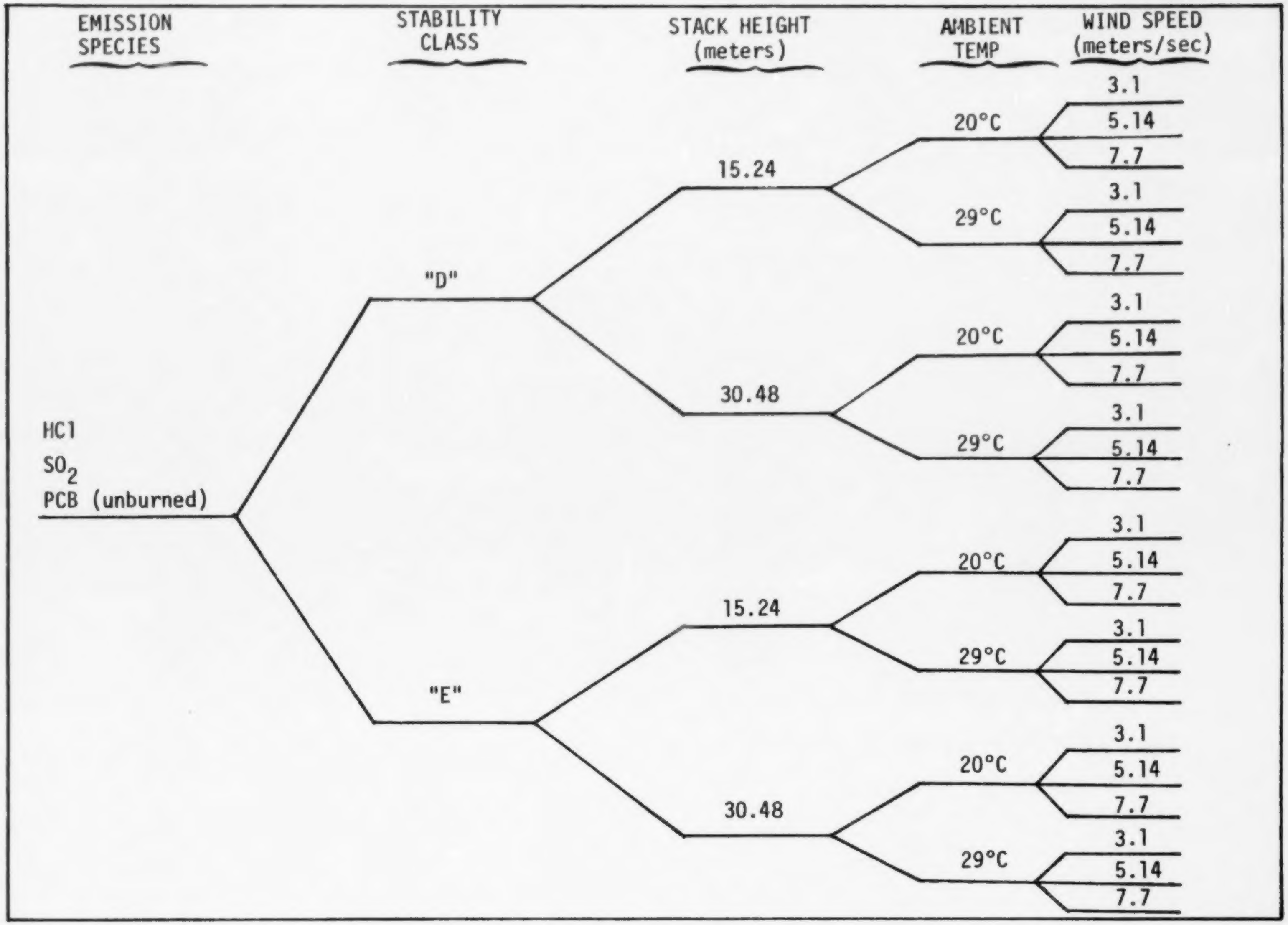
*The Gaussian analysis has been expressed in normalized values (i.e., concentration per unit of effluent mass flow) to allow for use with any emission rate. The use of these values is limited to the ambient parameters, design parameters, effluent flow veolcities, and effluent temperatures indicated for each case.

**There are no data available to substantiate this assumption. The reason for employing the assumption was to obtain an estimate of pollutant concentrations on-shore.


EMISSION SPECIES
STABILITY CLASS
STACK HEIGHT (meters)
AMBIENT TEMP
WIND SPEED (meters/sec)
HCl
SO_2
PCB (unburned)
"D"
"E"
15.24
30.48
15.24
30.48
20°C
29°C
20°C
29°C
20°C
29°C
20°C
29°C
3.1
5.14
7.7
3.1
5.14
7.7
3.1
5.14
7.7
3.1
5.14
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3.1
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5.14
7.7

Figure 32. Air Quality Simulation Scenarios

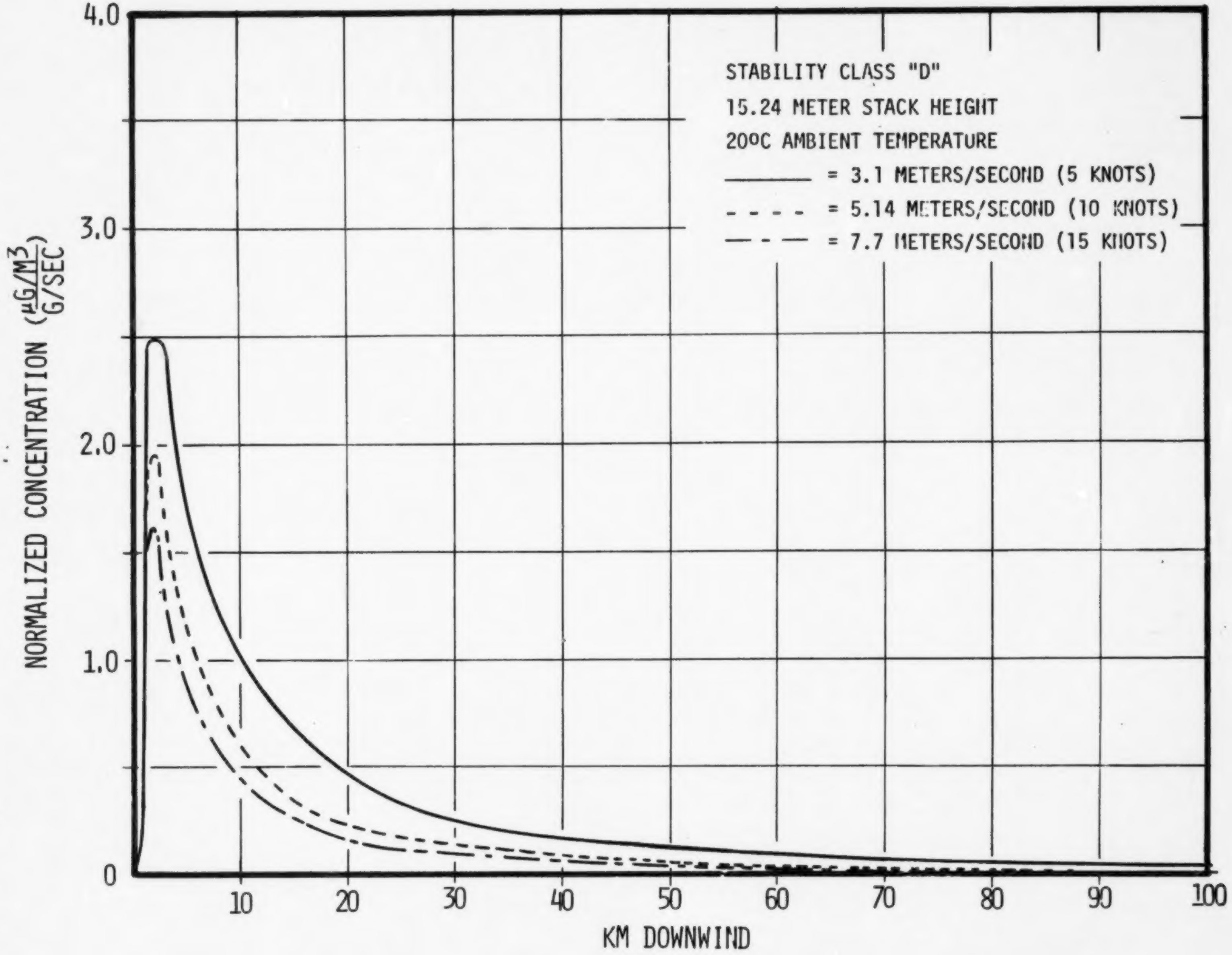

Figure 33. Variation of Air Quality Concentration with Downwind Distance from the Stack: Case 1.

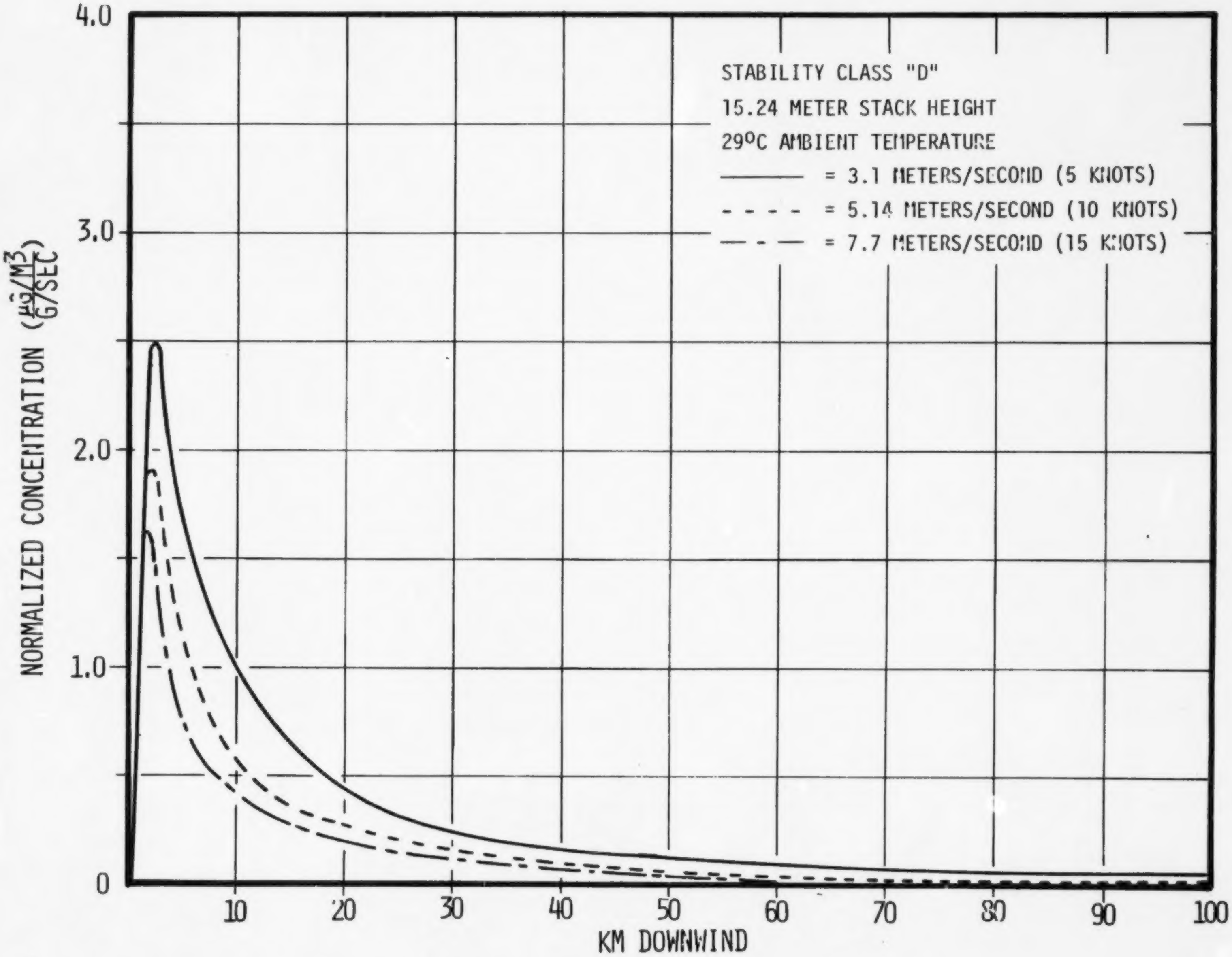

Figure 34. Variation of Air Quality Concentration with Downwind Distance from the Stack: Case 2

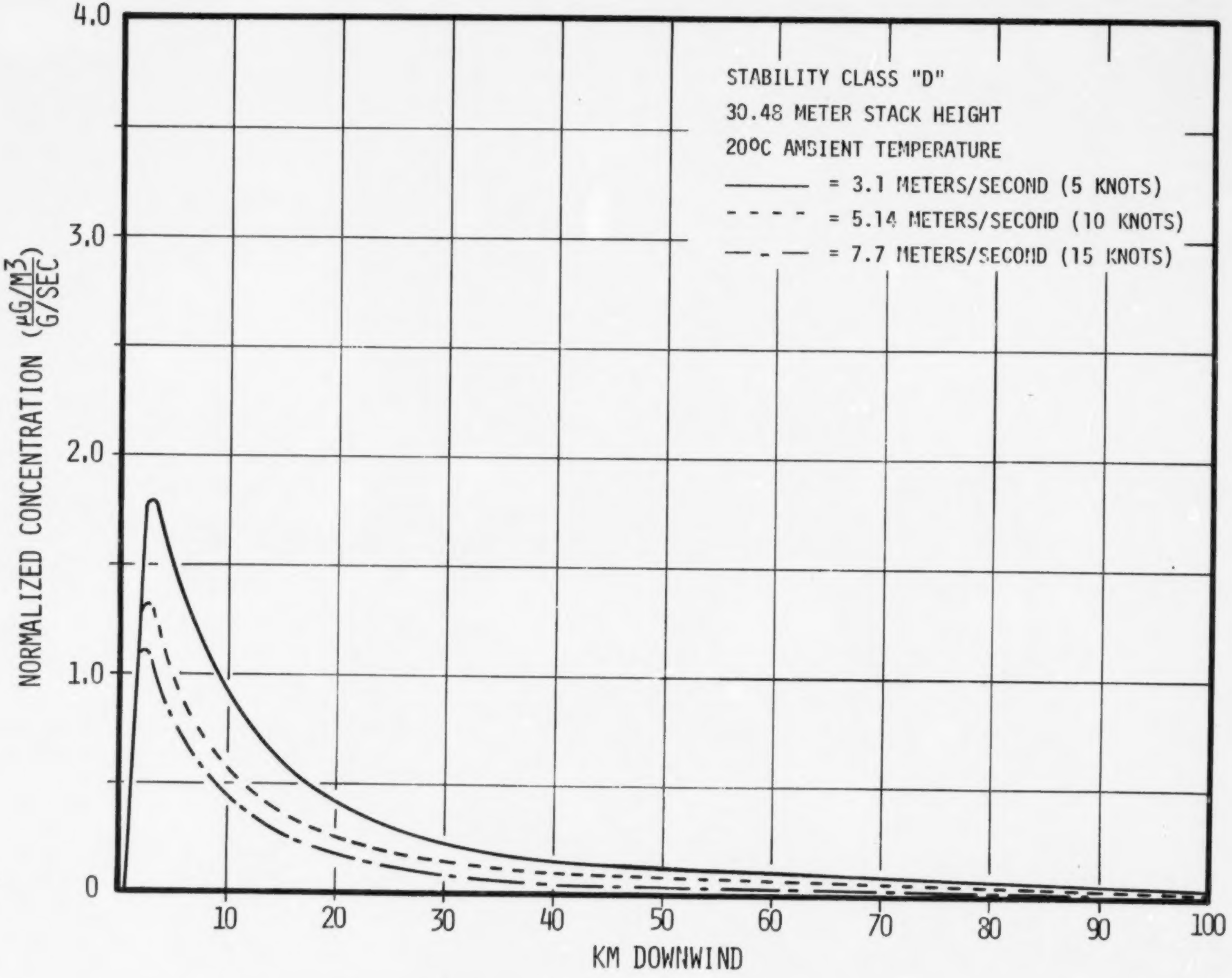

Figure 35. Variation of Air Quality Concentration with Downwind Distance from the Stack: Case 3

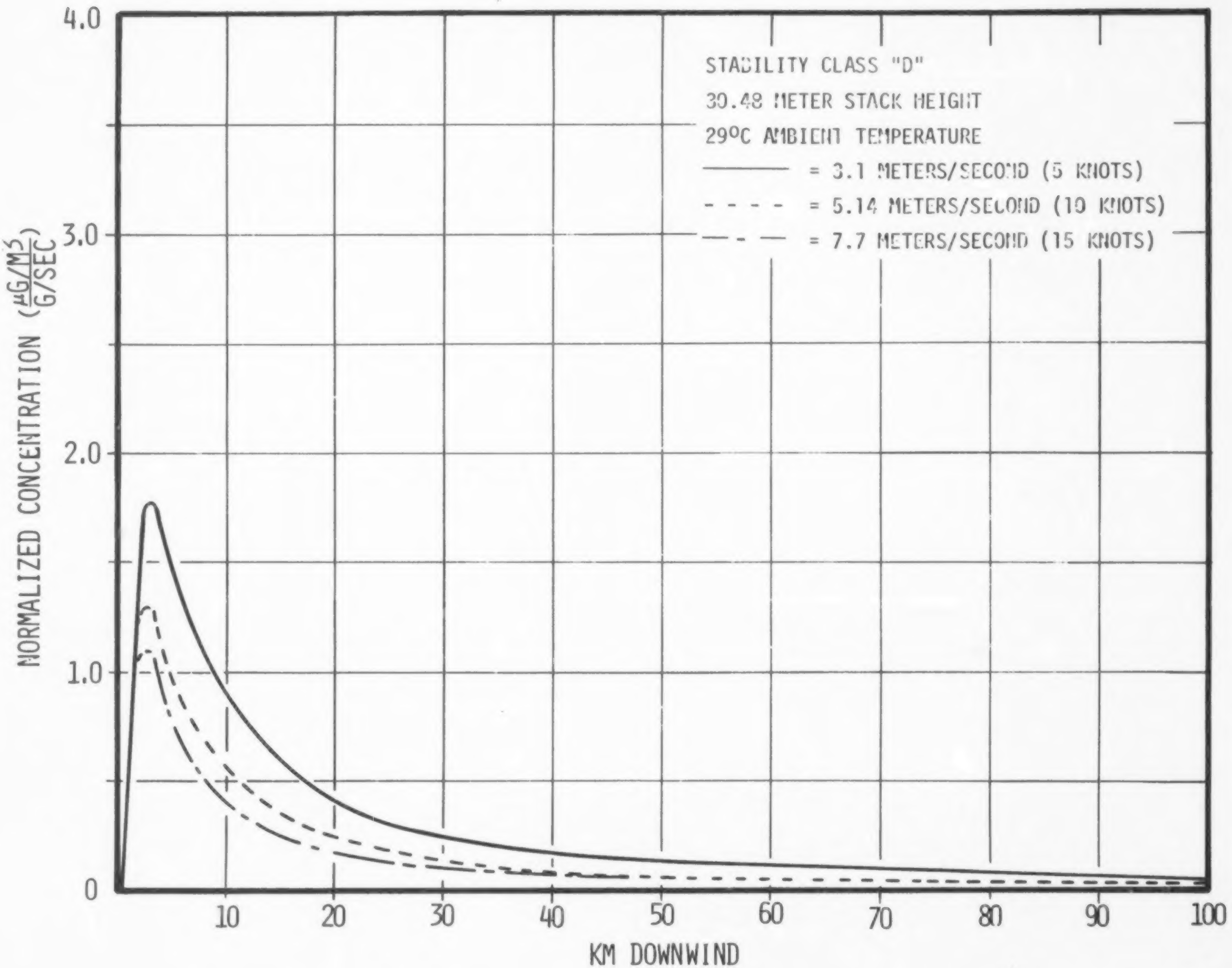

Figure 36. Variation of Air Quality Concentration with Downwind Distance from the Stack: Case 4

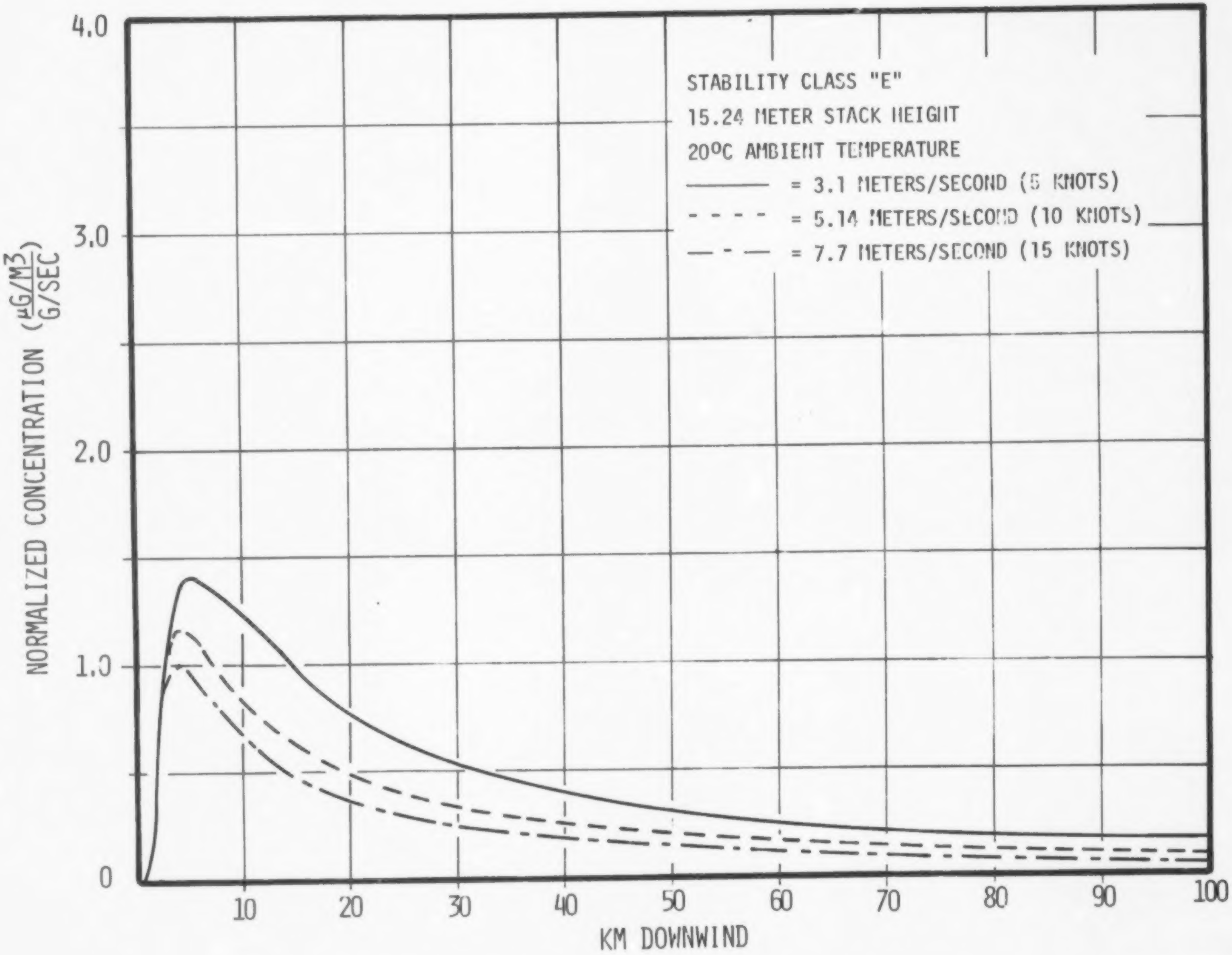

Figure 37. Variation of Air Quality Concentration with Downwind Distance from the Stack: Case 5

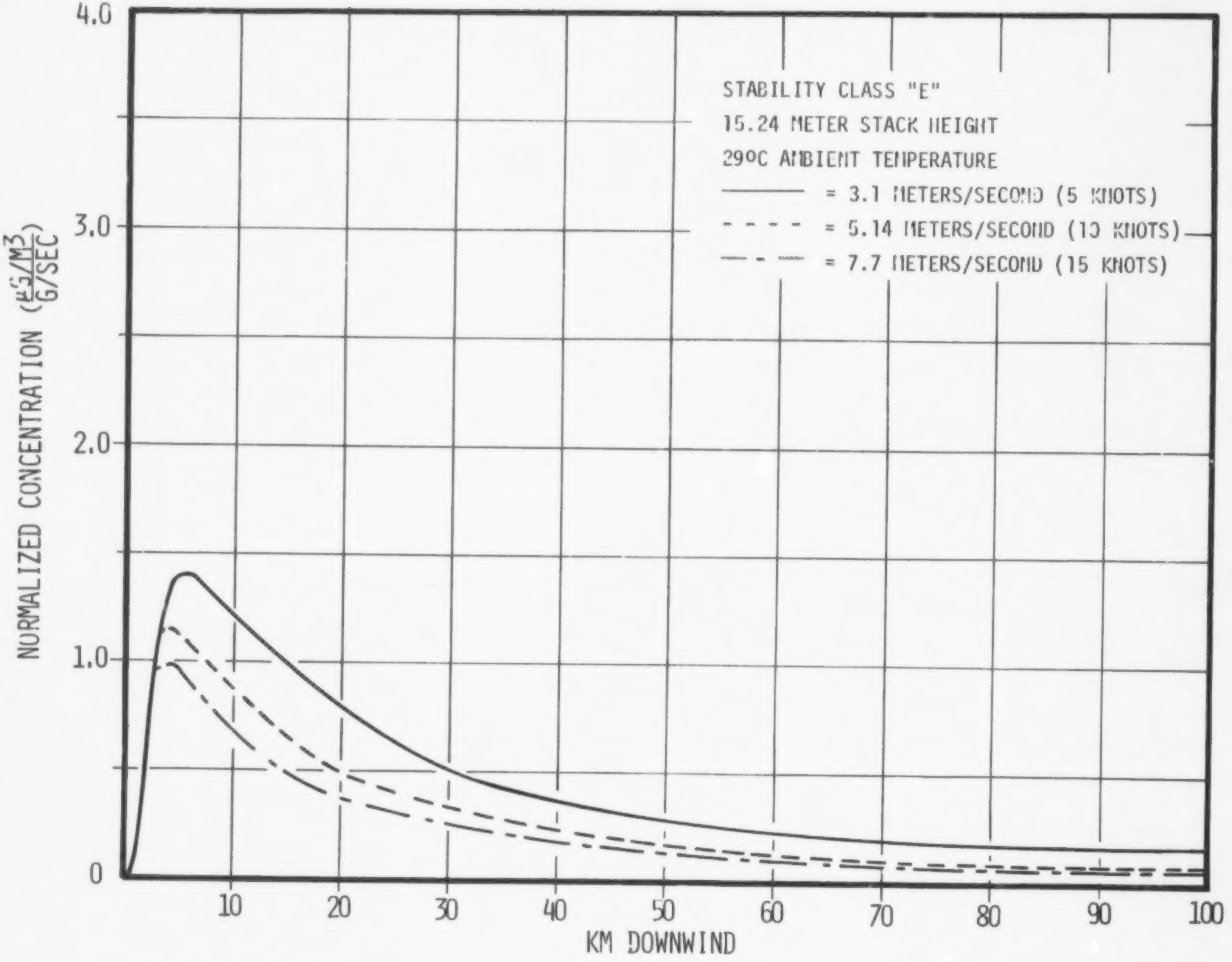

Figure 38. Variation of Air Quality Concentration with Downwind Distance from the Stack: Case 6

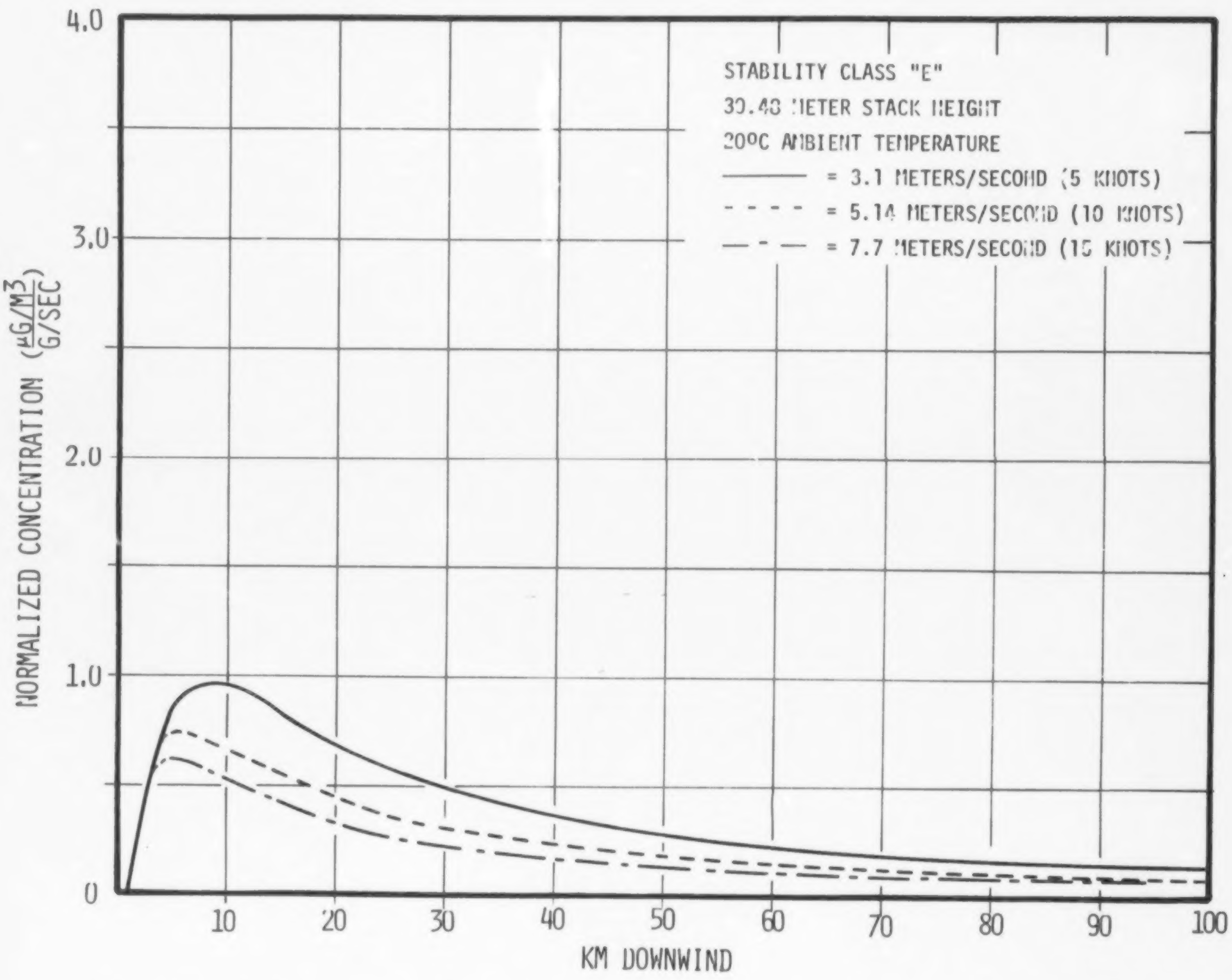

Figure 39. Variation of Air Quality Concentration with Downwind Distance from the Stack: Case 7

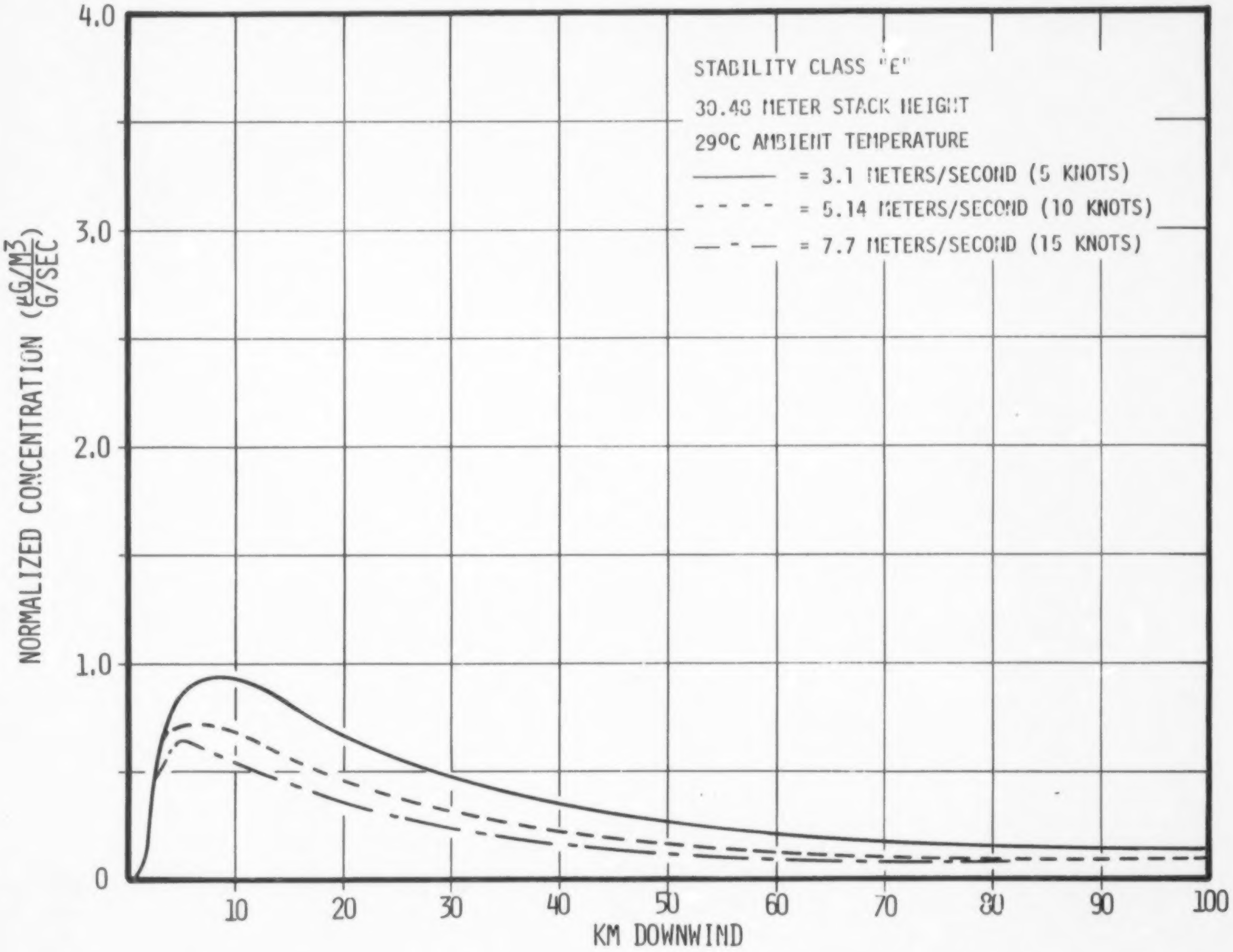

Figure 40. Variation of Air Quality Concentration with Downwind Distance from the Stack: Case 8

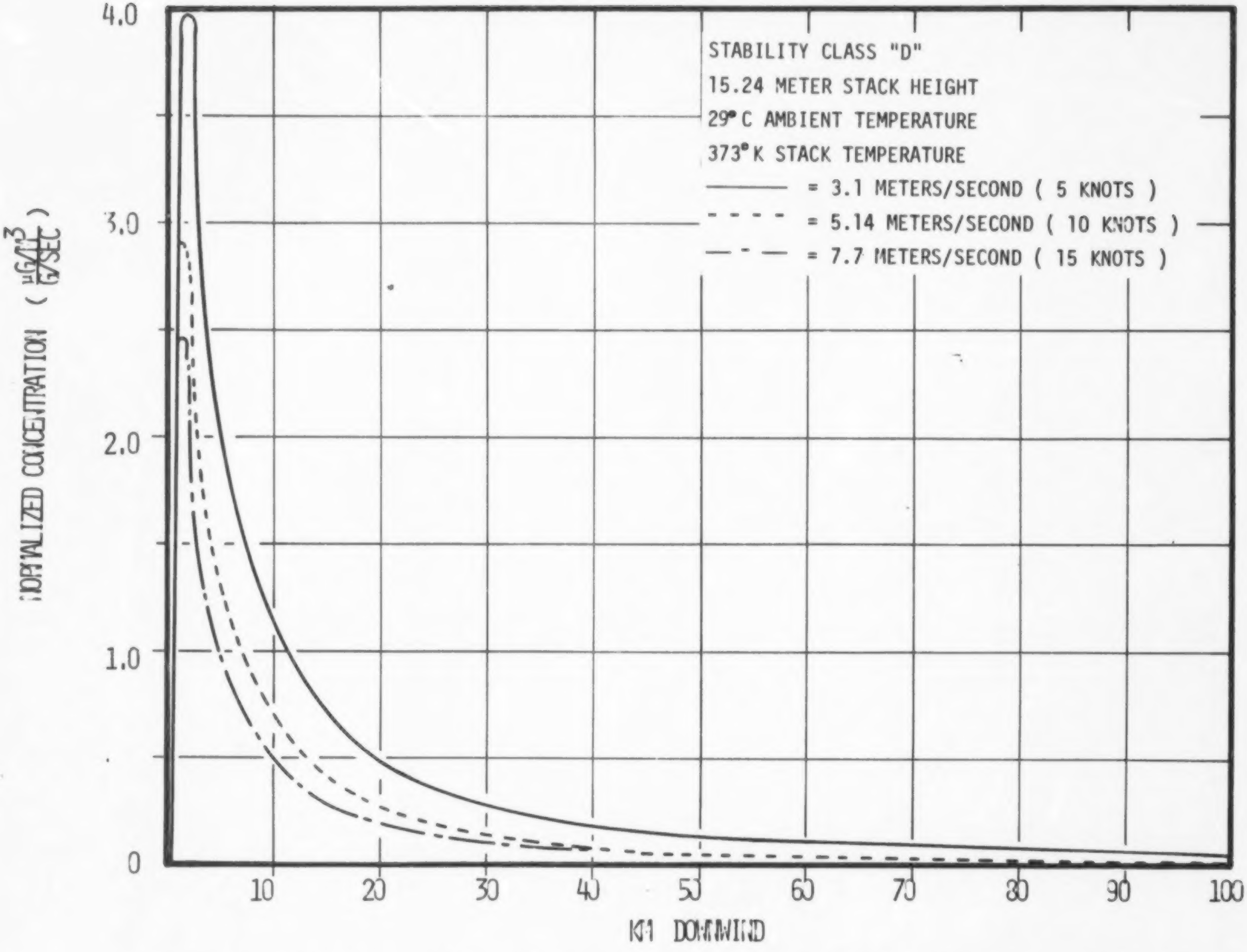

Figure 41. Variation of Air Quality Concentration with Downwind Distance from the Stack: Case 9

TABLE 25. EXPOSURE STANDARDS

Organization	HCL	SO_2	PCB
American Conference of Government Industrial Hygienists (Time Weighted 8-hour Average)	7 mg/m^3	---	
Occupation Safety and Health Administration (Time Weighted 8-hour Average)	---	---	1 mg/m^3 (42% CL content) 500 µg/m^3 (54% CL content)
NIOSH (Time Weighted 10-hour Average)	---	---	1 µg/m^3
EPA (National Ambient Air Quality Standard 24 Hour Average)	---	365 µg/m^3	
Odor Threshold (from Reference (21))	---	1100 µg/m^3	
"Worst Case" result at 100 KM (E class stability 15.24 M stack height, 3.1 m/sec wind, 20° and 29°C)	82.5 µg/m^3	3.2 µg/m^3	0.0006 µg/m^3

different averaging times. When one "converts" from a shorter to a longer averaging time (i.e., by the method of Larsen (22) or Turner (23)), the concentrations are decreased. In other words, an 82.5 microgram/m^3 9-hour averaging time for HCl, when "converted" to a comparable 40-hour averaging time, is less than 82.5 micrograms/m^3. This is another indication that the simulated results are much lower than the standards.

The results presented in Figures 37 through 40 for a 5.14 meter/second wind speed would best represent the "typical" situation for winter and summer ambient temperatures and either stack height under consideration.

For a given stability class, stack height and wind speed, increasing the ambient temperature from 20°C to 29°C (representative of average winter and summer temperatures, respectively) has no noticeable impact on concentrations (compare Figures 33 and 34).

For a given stability class, stack height and ambient temperature, increasing wind speed decreases peak ground level concentrations and shifts the peak closer to the source (see Figure 33). The latter effect is due to a lower plume rise* (ΔH), which causes the plume to "reach" ground sooner. The former is because the Gaussian model assumes that ambient concentrations are inversely proportional to wind speed (see Section 7.1.2).

For a given stability class, ambient temperature and wind speed, increasing the stack height decreases the peak ground level of concentration and and shifts the peak farther away from the source. This is consistent with the recognized fact that tall stacks generally aid in the dispersion of pollutants.

For a given stack height, ambient temperature and wind speed, a more stable atmosphere (i.e., changing from a "D" class to an "E" class) both decreases the peak concentration and shifts the peak farther downwind from the source. As an illustration, refer to the 3.1 meter/second wind speed curves in Figures 33 and 37. In Figure 33 ("D" class), the peak is at 2400 meters and has a value of 2.48, while in Figure 37 ("E"class), the peak is at 5000 meters with a value of 1.42. However, as one progresses downwind from the point of peak concentration, a more stable atmosphere gradually yields higher concentrations. Referring to the aforementioned examples, for distances greater than 7000 meters, the 3.1 meter/second curve for the "E" class (Figure 37) has consistently higher values than the corresponding curve for the "D" class (Figure 33). Thus, all else being equal, residents on shore would be exposed to higher concentrations as the atmosphere becomes more stable.*

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*The higher the wind speed, the lower the effective plume rise. See Section 7.1.4.2.

The impact of reducing stack gas temperature to 100°C (from 300°C) is shown in Figure 41 (compare Figure 41 with Figure 34, which shows results for 300°C). The value of the peak concentration is increased from 2.48 to 3.99 and is moved closer to the source (1800 meters versus 2400 meters). Both are consequences of reduced plume rise.

7.1.2 Description of the Model

A standard Gaussian diffusion and transport model was utilized to simulate the air quality changes expected as the result of the incineration activities. The basic equation used in the calculation is:

$$\chi(x,y,z;H) = \frac{Q}{2\pi\,\sigma_y\sigma_z u}\ \exp\left[-\,y^2/2\sigma_y^{\,2}\right]\left\{\exp\left[-(z-H)^2/2\,\sigma_z^{\,2}\right] + \exp\left[-(z+h)^2/2\,\sigma_z^{\,2}\right]\right\}$$

where : $\chi(x,y,z;H)$ = concentration downwind from the source at location (x,y,z) (grams/ m^3)

H = effective stack height (meters)

Q = continuous point source strength (grams/second)

u = mean wind speed (meters/second)

σ_y , σ_z = horizontal and vertical dispersion coefficients (meters)

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*Because the reliability of dispersion models is questionable at extended distances (greater than 50 km), one should regard the on-shore concentrations shown in Figures 33 through 41 in a relative sense only.

To obtain groundlevel downwind concentrations at the plume centerline, the equation reduces to:

$$\chi(x,0,0;H) = \frac{Q}{\pi \sigma_y \sigma_z u} \exp\left[-\frac{1}{2}\left(\frac{H}{\sigma_z}\right)^2\right]$$

7.1.3 Limitations of the Model

When gases and particulates are released from a point source they are carried downwind and dispersed primarily by atmospheric turbulence. Particulates will have an additional downward component of velocity at their terminal velocity, v_s. As the gases or particulates approach the ground, a fraction will be deposited on the surface by direct sedimentation, inertial impaction, adsorption, chemical reaction and other mechanisms. In the conventional Gaussian plume model described earlier, no account is made for gravitational settling of particulates or for the deposition mechanism. Although modifications have been suggested to include these factors, the lack of available data makes it difficult to use these modifications. A more rigorous analysis was not warranted for this study but should be included in subsequent environmental impact assessments.

The atmospheric diffusion and transport of pollutants over water is different from that over land for comparable stabilities. Van der Hoven (1) reported that on the average, overland diffusion is two to three times more rapid than overwater diffusion when the water surface temperature is colder than the air temperature over land. According to measurements and calculations made by Slade, pollutant concentrations over water for distances up to 10,000 meters from the source average 1.5 times greater than over land for the Chesapeake Bay (2). Raynor et al, in experiments performed off the coast of Long Island, New York, obtained results which showed measurements of plume width and height which are smaller and normalized concentrations which are larger than those predicted for the Pasquill F category (3). (The "F" category represents an extremely stable atmosphere over land.)

The turbulence spectrum (and hence the diffusion) over water has been found to depend on air-water temperature differences and the roughness of the ocean surface. With colder water, low level air is very stable and diffusion is minimal, but water warmer than air induces vigorous diffusion. Vertical diffusion rates over water surfaces have been shown to be slower than over land by a factor varying from two to ten, depending on the atmospheric stability near the surface (1). Although the character of diffusion is clearly dependent on the air-water temperature differences, these are difficult to define accurately for several reasons. Low level air temperature and lapse rate measurements are subject to several causes of error in the marine environment (3). Thus, prediction of plume behavior from several temperature measurements is subject to uncertainties.

Another area of potential uncertainty occurs when the plume reaches land. A marked change in the underlying surface can induce significant changes in the mechanical and thermal turbulence of the flow and, consequently, significant changes in the diffusion rates of the atmosphere. The turbulence induced by the rough heated land surface begins at the shoreline and builds upward and inland. At the point where the turbulent land surface layer intersects the stable elevated plume, rapid downward mixing occurs.

At present, there does not appear to be an accepted or commonly recognized analytical method of estimating dispersion over water. Although Gifford (4) has suggested in principle a method for obtaining equivalent Pasquill-Gifford stability curves over water, the data requirements of this scheme are beyond the scope of this project. Meteorological parameters which characterize stability conditions are also lacking for the incineration site.

7.1.4 Adaptions/Modifications of the Model

No modifications were made to the standard Gaussian model to account for any of the limitations discussed in Section 7.1.3. However, an attempt to simulate dispersion over water was made through the selection of appropriate meteorological conditions. The "D" stability class predominates over Mobile, Alabama (see Table 26. Because no stability data are available for the incineration site, the normal procedure would be to assume that "D" stability also prevails over the site. As dispersion over water appears to be less rapid than over land, this condition is "simulated" by assuming the atmospheric condition to be more stable than the prevalent one. Thus, an "E" class, as well as the "D" class, was modeled.

7.1.5 Model Inputs

This section describes the meteorological variables and stack parameters utilized in the dispersion model.

7.1.5.1 Meteorology

The climate of the northern Gulf of Mexico and adjacent coastal region is determined by three major factors: the North American continental land mass, the subtropical latitude, and the relatively warm waters of the Gulf of Mexico itself. The principle influence is the Gulf, resulting in a maritime tropical climate for the region.

During the winter, polar continental air masses move southward into the Gulf of Mexico causing occasional sudden drops in temperature. As these cold fronts reach the Gulf of Mexico, the maritime tropical air flowing northward causes the fronts to abate and become stationary. These stationary fronts are favorable for the formation of low centers that often move west to east along the Gulf Coast or move inland, producing low clouds and rain. The cold continental air masses have a tendency to lower the sea surface temperature offshore. The cold water temperatures cause the formation of advective fog in coastal areas from November to March.

By spring, the Bermuda high develops its influence over the region, thus improving the weather considerably. The ridge of high pressure usually blocks the movement of storm systems from the west. Occasionally, tropical disturbances and easterly waves will appear in the Gulf of Mexico by early summer.

During the summer, southerly winds of the Bermuda high bring warm moist tropical air onshore. Daily shower activity occurs near shore

TABLE 26. RELATIVE FREQUENCY OF STABILITY CLASS OCCURRENCES

Mobile, Alabama (1970 - 1974)

PASQUILL STABILITY CLASS	SEASON (MONTHS)				
	DJF	MAM	JJA	SON	ANNUAL
A	.000833	.005978	.013862	.004670	.006370
B	.020278	.048098	.095678	.052747	.054387
C	.073056	.097283	.151128	.125549	.111925
D	.616111	.532065	.289753	.359615	.448729
E	.137778	.146467	.188910	.163736	.159326
F+G	.151944	.170109	.260669	.293681	.219262

Pensacola, Florida (1970 - 1974)

PASQUILL STABILITY CLASS	ANNUAL
A	.003767
B	.053702
C	.123159
D	.220084
E	.248031
F+G	.351257

Source : References (5) and (6)

waters and along the coast with most activity in the afternoon. Westerly and northerly winds generally bring periods of hotter and drier weather into the region.

Easterly waves and tropical storms appear in the Gulf during the late summer and early fall. The principal paths of tropical storms into the Gulf are through the Yucatan Channel and the Straits of Florida. Over half of these tropical storms become hurricanes during this season. During October and November, the Bermuda high loses its strength and allows continental air again to exert influence on the Gulf of Mexico and coastal region.

Average temperatures at coastal locations vary with latitude and exposure. In winter they depend on the frequency and intensity of penetration by polar air masses from the north. These incursions, when they bring strong northerly winds, are called "northers" and may occur 15 to 30 times from November through March. Air temperatures over the open Gulf exhibit narrower limits of variation both on a daily and seasonal basis. In the summer, average temperature over much of the Gulf is about 29°C. Winter air temperatures in the eastern Gulf near coastal areas average between 17°C and 20°C.

The input variables utilized in the dispersion model are displayed in Table 27. As indicated in Section 7.1.4 two stability classes -- "D" and "E" -- were chosen. Data from Reference (19) indicate that the mean wind speed in the vicinity of the incineration site is 10 knots or 5.14 meters/second. The two other wind speeds were arbitrarily selected to illustrate the variation of ambient concentration with wind speed. The ambient temperatures -- 29°C (summer) and 20°C (winter) -- were also obtained from Reference (19).

7.1.5.2 Stack Parameters

The stack parameters are shown in Table 28. Two stack heights and three waste types were modeled. The calculation of the effective stack height, H, is based on the equation:

$$H = h_s + \Delta h + h_p$$

where h_s = physical height of the stack (meters)

TABLE 27. METEOROLOGICAL INPUT VARIABLES

Stability Class : "D" and "E"

Wind Speeds : 3.1 meters/second (5 knots)
5.14 meters/second (10 knots)
7.7 meters/second (15 knots)

Ambient Temperature : 20°C (winter)
29°C (summer)

TABLE 28. STACK PARAMETERS

Stack Heights : 15.24 meters (50 feet)
30.48 meters (100 feet)

Stack Diameter : 0.455 meters
Stack Gas Temperature : 300°C
Stack Gas Effluent Velocity : 11 meters/second
Platform Elevation Above Sea Level : 20.3 meters (68 feet)
Emission Rates : HCl = 542.5 grams/second
SO_2 = 21.08 grams/second
PCB (unburned) = 0.004 grams/second

Δh = plume rise above the stack mouth (meters)

h_p = height of platform above water surface (meters)

and $$\Delta h = 2.6 \left\{ \frac{F}{\mu s} \right\}^{\frac{1}{3}}$$

where μ = wind speed (meters/second)

$$s = \left(\frac{g}{T} \right) \left(\frac{\delta \theta}{\delta z} \right)$$

$$F = \frac{\Delta T}{T_s} g w r^2$$

and g = gravitational acceleration (m/sec^2)

T = absolute temperature of the ambient air

$\frac{\delta \theta}{\delta z}$ = potential temperature gradient (degree/meter)

ΔT = stack effluent temperature minus ambient temperature

T_s = absolute temperature of the stack gas

w = stack gas exit velocity (meters/second)

r = stack radius (meters)

The plume rise equation (Δh) was formulated by Briggs and is extracted from Reference (1). No attempt was made to account for the influence (if any) of the kiln/afterburner temperature (approximately 200°C) on the plume rise.

The behavior of plumes from short stacks* near or on buildings is complicated by factors such as the shape of the building, surrounding terrain and gustiness of the wind. Observations of short stacks emitting smoke from a building indicate that three distinct types of plume behavior may often be discerned with a period of a minute or two:

---

*A stack which is less than 2.5 times the building height is considered to be short.

1. Full Cavity Effect. The plume is strongly deflected into the low pressure field above and in the lee of the building and a large area of the building seems to emit the plume. The building becomes a virtual area source.

2. Aerodynamic Downwash Effect. The plume's centerline rapidly descends to the surface. Apparently the plume follows a trajectory immediately above the low-pressure cavity and is brought to earth in the descending streamflow behind the building.

3. Elevated Source Effect. The plume behaves as though emitted from an isolated source and is not visibly affected by surrounding buildings.

Experimental results have indicated that the ratio of stack exit gas velocity to wind speed is a primary factor in determining the downwind distance from the building at which the plume's centerline will approach the surface. The greater the ratio of wind speed to stack gas exit velocity, the shorter the downwind distance at which a plume's centerline will be deflected toward the surface. If wind speeds are low, the wake or aerodynamic downwash effect is avoided.

Because the physical height of the stack (15.24 meters) is greater than 2.5 times the height of the closest structure, building downwash is not anticipated to be a problem (20). This does not imply that personnel on the platform will not be exposed to stack effluent, as the plume may be subject to the "looping" phenomenon. During looping, the plume may touch ground extremely close to the stack. (Looping occurs during extremely unstable atmospheric conditions i.e., "A" class stability). However, "A" stability is expected to occur rather infrequently in the vicinity of the platform (see Table 26), and downwash, therefore, is probably not likely to happen.

Values for stack gas characteristics used in the model were derived from consideration of a typical chlorinated hydrocarbon liquid waste previously burned at sea. This waste derives from the manufacture of allyl chloride, epichlorohydrin, dichloroethane, and vinyl chloride, and is designated a chemical manufacture waste (CMW). It was selected because of the high chlorine content (62.6 wt %) and heating value (16,166 Kj/Kg). Higher chlorine content waste would probably require addition of auxiliary fuel for complete combustion. Thus, the CMW represents a "worst case" for

HCl pollution. By assuming reasonable contamination with sulfur compounds, and with PCB's, CMW can also be used for study of comparative impacts of substantially different pollutants. The stack gas effluent velocity was derived using an approximation of 100% excess air, with waste feed of three metric tons per hour. The stack effluent mass flow rate under these conditions is 29,000 Kg/hr. Emission rates (g/sec) for the two pollutans HCl and SO_2 were then calculated for the stack gas. For the unburned PCB, a reasonable emission rate was obtained from consideration of destruction efficiencies observed in previous burns.

7.2 Water Quality Impacts

Operation of the incinerator may affect water quality in the vicinity of the platform in two ways. First, the direct effluent from the quench and scrubber systems will contain heat and pollutant species such as Cl^-, $SO_3^=$, particulate, and unburned traces of the original waste. Second, a fraction of the material escaping from the stack will enter the aquatic environment through precipitation scavenging or direct contact with the water surface. This latter condition is called plume touchdown. A dynamic model has been developed to estimate the direct effluent concentrations under various conditions. Details of the model and results derived from it are given in Section 7.2.3. A methodology has also been developed to estimate transfer of pollutants across the air water interface and determine the resulting water concentration. This is described in Section 7.2.4.

7.2.1 Conclusions

The overall impact on the water quality will depend on contributions from both the direct effluent and the plume touchdown. Data from these two analyses are contained in Sections 7.2.3 and 7.2.4. The highest concentrations from the direct effluent will be found in the immediate vicinity of the discharge pipe. The highest concentration from plume touchdown will occur either very close to the platform or at about 10,000 meters, depending on whether the current is flowing away from or toward the platform. Theoretically, the former case will be the worst, because the highest concentrations in each case will sum together. However, the values from the plume touchdown analysis are much lower than those due to the direct effluent, and become negligible in comparison. However, this is not to say that these concentrations are not significant by themselves. PCB concentrations from the plume touchdown alone could be high enough to cause an ecological hazard.

7.2.2 Ocean Parameters

The ocean parameters of interest here are physical and chemical characteristics. These include floor morphology, currents, density stratification, and turbulence level.

7.2.2.1 Floor Morphology

One characteristic of the platform site is that it lies at the edge of the Mississippi-Alabama continental shelf. The platform stands in 100 meters of water, which quickly doubles in the direction of the open sea. On the other hand, decrease of depth towards shore is very gradual. This is depicted graphically in Figure 42.

7.2.2.2 Currents

Current patterns on the Mississippi-Alabama shelf are very complex, and the scarcity of data prevents detailed characterization. For the Mobile-Pascagoula region, surface currents can be generalized as in Table 29.

TABLE 29. GENERALIZED SURFACE CURRENTS IN PLATFORM AREA

Direction	Intensity	Months Condition Prevails
West	25-50 cm/sec	January-April, July-December
East	25 cm/sec	April-July

Source: Reference 25

Current profiles as a function of depth could not be found for this area. The overall current pattern is influenced by meteorological conditions, astronomical tides, intrusion of the loop current onto the shelf, and density gradients from river runoff. The surface layer is strongly

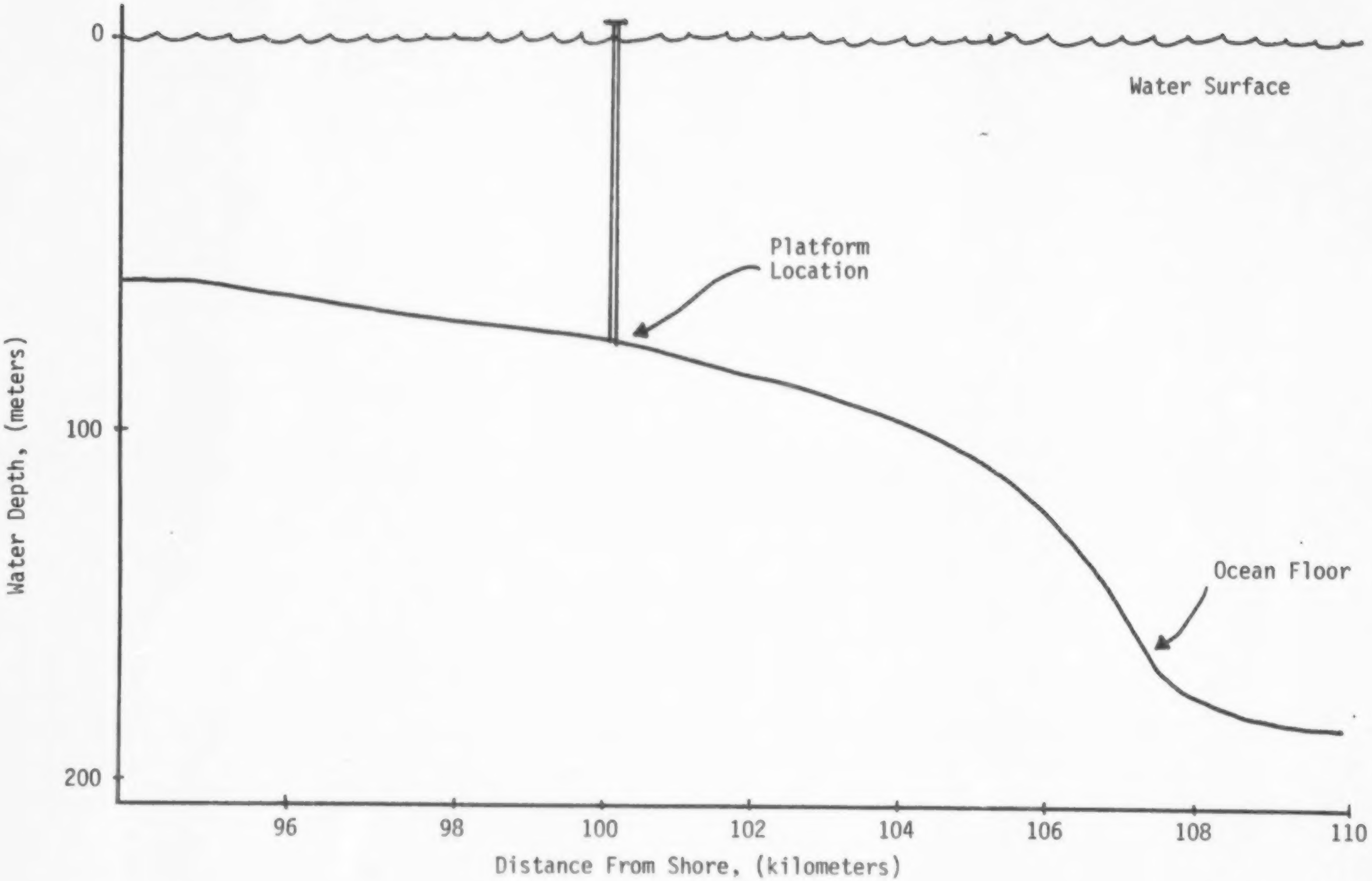


Figure 42. Longitudinal Profile Through Platform Site

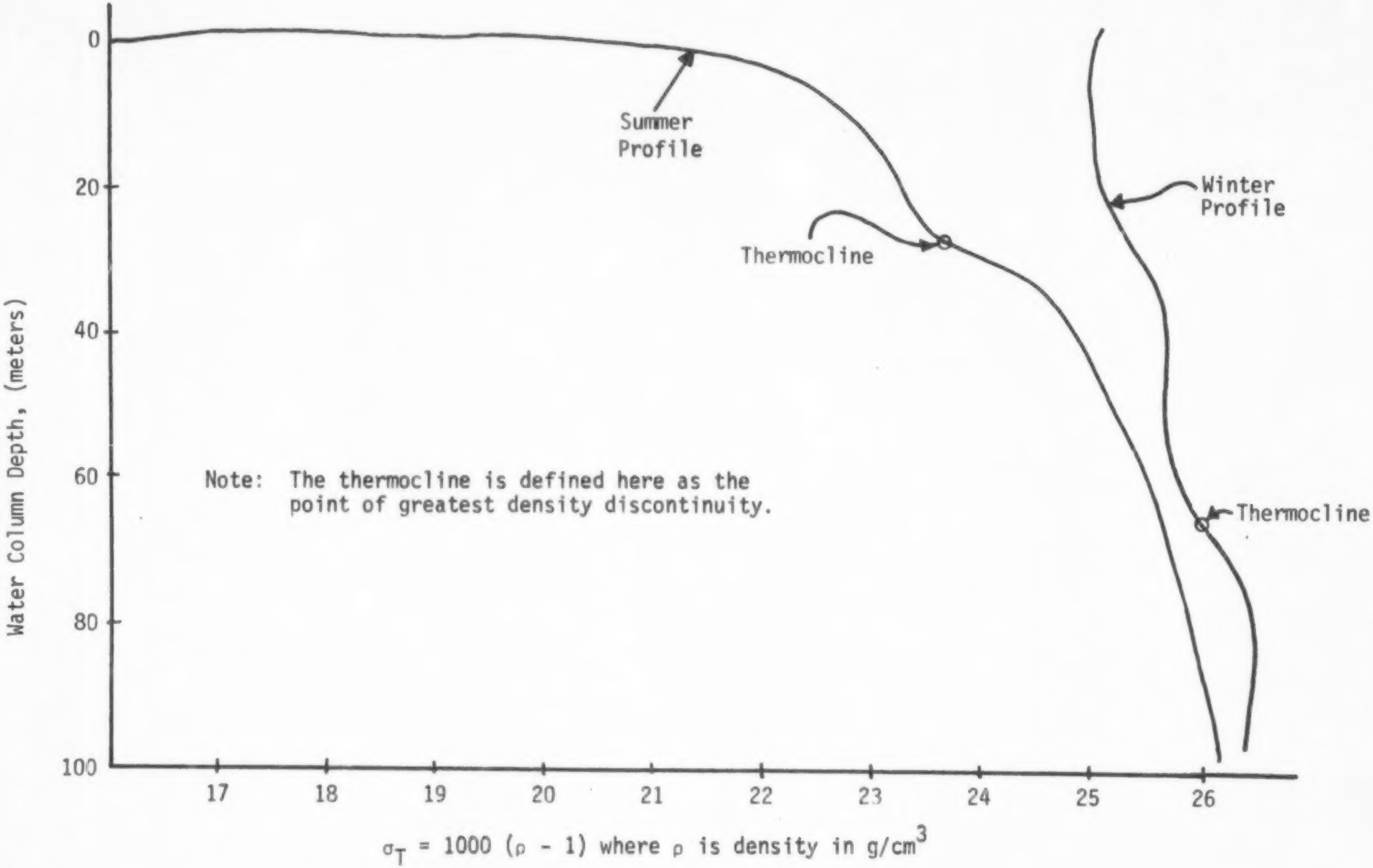
Source: Reference 24

affected by seasonal winds and storm systems, as well as by meteorological tides. Theoretical calculations indicate wind induced surface currents as high as 17 cm/sec in the winter months. The intensity of this current diminishes with depth (26). In addition, strong winds blowing perpendicular to the shore induce meteorologic inertial tides stronger than the astronomical tides. Inertial tidal currents measuring 10-30 cm/sec have been observed on the Florida shelf, with corresponding astronomic tidal currents of 5 to 20 cm/sec (27). Similar effects have been observed in the platform area, where water levels change 0.3 to 0.7 meters due to astronomical tides, and 0.6 to 1.2 meters due to inertial tides. Hurricanes may raise the water level 3 to 7.5 meters (25). It should be pointed out, however, that because of their diurnal character, the astronomic tides may play an important role in pollutant dispersion (28). Astronomical tides are also seasonal, having their greatest effect in the springtime.

No data are available for the loop current or fresh water intrusions. The loop current originates as an influx of water through the Straights of Yucatan, and is the major forcing function for the overall current activity in the Gulf of Mexico. During the summer, the loop current can penetrate as far north as the platform site, so some upwelling from the nearby dropoff can be expected. During the winter months, the loop takes a more direct route out of the gulf, but a detached eddy may remain in the northern region. The influence of this current is always west to east. Fresh water emerging from the river channels creates plumes of low salinity with enough momentum to affect local currents. The differences in density also contribute to some water movements.

7.2.2.3 Density Stratification

Complete profiles of temperature, salinity, and density are given for this part of the gulf. Since density is a function of both temperature and salinity, it can be a more useful parameter than the other two. The stratification of a water column refers to its having layers of different density. This is a seasonally changing phenomenon since different influxes of solar energy will affect temperature and different current patterns may affect both temperature and salinity. Figure 43 shows density profiles for a summer and winter case. The symbol "σ_T" represents a unit of measure used to express seawater density in a convenient form. Note that the



Note: The thermocline is defined here as the point of greatest density discontinuity.

Figure 43. Density Profiles for Summer and Winter Cases

Source: Reference 26

summer case is less dense overall but particularly so near the surface. This is due to the intense solar heating of summer months. Large changes of density in these profiles inhibit vertical mixing. The point where density changes the most is where mixing is poorest. This point is called the thermocline and is indicated on Figure 43. The position of the thermocline is important because this is where the greatest current velocity discontinuity would be expected. Currents typically approach surface values above the thermocline and are relatively calm below it. The summer case actually has its largest density discontinuity at the surface, but this is a trivial case. Surface values for density, temperature, and salinity are shown in Table 30.

TABLE 30. PARAMETERS AT THE WATER SURFACE

Parameter	Summer Case	Winter Case
Density, ρ	1.016 g/cm^3	1.025 g/cm^3
Temperature, T	31.0°C	21.2°C
Salinity, S	28.0 ppt	35.7 ppt

Source: Reference 26

Wave power in the Gulf of Mexico is relatively weak compared to other ocean systems. This is the factor contributing to most ocean turbulence. The average wave height near the coast is 0.9 meters, and 75% of all waves are smaller than 1.5 meters. Both strength and direction correlate closely to wind intensity and direction, respectively. Wave induced turbulence is two to three times greater during autumn and winter than during spring and summer (24).

7.2.3 Liquid Effluent from Quench and Scrubber

This section will document the use of a simulation analysis to determine impacts of liquid effluent from the quench and scrubber systems on the physical water environment. A model has been developed which can calculate the dilution effect of the ocean on the effluent flow given a set of input conditions. Cases have been run for many situations of interest, including an effort to find an optimum design for the outfall pipe. The resulting dispersion patterns are examined, and conclusions and recommendations are made.

7.2.3.1 Description of the Model

The conceptual design of the model is to treat the liquid effluent as a plume emanating from what is effectively a point source. The plume will initially have some momentum and a density discontinuity with the ambient density. As soon as it leaves the discharge pipe, entrainment of ambient fluid will begin, and the extent of this dilution will determine the concentrations and temperature within the plume. The essential purpose of the model is to calculate dilution factors for a number of points along the centerline of the plume so that actual physical parameters can be determined.

There are two entirely different regimes in this dilution process. In the first, the plume has sufficient momentum relative to the ambient fluid that mixing is accomplished largely through shear forces acting on the walls of the plume. This is the "buoyant plume" regime. After the plume has lost some momentum, the ambient turbulence begins to play an important role. This is the "ambient dispersion" regime. A special case occurs if the plume reaches the surface of the water. It is then referred to as a "surface jet", but can act in either of the regimes mentioned above. Table 31 lists the basic assumptions and limitations of the model.

Buoyant Plume

In this portion of the model, relative motion of the plume is the dominant cause of mixing. Accordingly, the equations of fluid dynamics must be solved as a set of simultaneous differential equations (29,30). These are as follows:

Conservation of Mass

$$\frac{d}{ds}(\pi b^2 \rho u) = 2\pi b \alpha \rho_\infty |u - v\cos\Theta| + 2\pi b \beta \rho_\infty |v\sin\Theta|$$

Conservation of Momentum (tangential to plum centerline)

$$\frac{d}{ds}(\pi b^2 \rho u^2) - v\cos\Theta \frac{d}{ds}(\pi b^2 \rho u) = -\pi b^2 g \sin\Theta(\rho - \rho_\infty)$$

Conservation of Momentum (perpendicular to plume centerline)

$$\pi b^2 \rho u^2 \frac{d\Theta}{ds} + v\sin\Theta \frac{d}{ds}(\pi b^2 \rho u) = -\pi b^2 g\cos\Theta(\rho - \rho_\infty)$$

TABLE 31. BASIC ASSUMPTIONS AND LIMITATIONS OF THE WATER QUALITY SIMULATION MODEL

- The plume has reached a steady state.
- The plume has circular cross section, except in surface jet situations, where the plume is semicircular.
- Profiles of density and velocity at cross sections have approximately normal distribution.
- Large particulate (generally greater than 10 microns) cannot be modeled, since they will settle rather than follow plume trajectory.
- Plume trajectory has "reasonable" shape. The model cannot account for turns so sharp that the plume doubles over on itself.
- The initial cross-sectional radius is small compared to the length dimension being considered.

Conservation of Energy

$$\frac{d}{ds}[\pi g b^2 u(\rho-\rho_\infty)] = -\pi g b^2 u \frac{d\rho_\infty}{dz} \sin\theta$$

All variables are defined in Table 32. The analytical procedure is to apply the chain rule to these equations to obtain terms containing derivatives of b, u, ρ, and θ. Numerical results for these derivatives can be obtained by solving a four-by-four matrix of simultaneous equations. Finally, an Adams-Moulten numerical integrator is used to solve these equations as well as the final expression for the extent of dilution.

Extent of Dilution

$$\frac{d}{ds}(\pi b^2 \rho u c) = 0$$

Every pass through the integrator generates values for plume width (b), plume angle from horizontal (θ), plume velocity at centerline (u), and plume density at centerline (ρ), as well as the dilution factor (c). This number is based on a normalized concentration of 1.0 at the effluent pipe.

Ambient Dispersion

The general equation describing ambient turbulent diffusion is:

$$\frac{\partial}{\partial y}\left(K\frac{\partial c}{\partial y}\right) = v\frac{\partial c}{\partial x}$$

By assuming similar Gaussian profiles over the cross section of the plume, a solution can be obtained in terms of the downstream growth of the standard deviation relative to some initial values, given here as σ^* and s^* (31).

$$\sigma = \frac{\varepsilon}{v^{3/2}} \left[s + v \left(\frac{\sigma^*}{\varepsilon}\right)^{2/3} - s^*\right]^{3/2}$$

$$\varepsilon = a\partial^{2/3}$$

$$a = 4.911$$

$\partial = f(K)$, determined from correlation
of actual ocean data (32).

TABLE 32. DEFINITION OF VARIABLES

b = plume width.

u = plume velocity along centerline.

ρ = plume density along centerline.

Θ = angle plume makes with horizontal

s = arc length along centerline of plume.

x = horizontal component of s.

z = vertical component of s.

c = pollutant concentration along centerline.

σ = standard deviation of pollutant concentration over a cross section.

v = ambient water velocity at a given depth.

ρ_∞ = ambient water density at a given depth.

α = longitudinal entrainment constant.

B = transverse entrainment constant.

K = ambient diffusivity constant.

π = circular constant.

g = gravitational constant.

The change in pollutant concentration is inversely related to the change in standard deviation.

The downstream pollutant concentration is defined by:

$$\frac{c}{c^*} = \frac{\sigma^*}{\sigma}$$

Changeover from buoyant plume to ambient dispersion calculation occurs when the extent of mixing by ambient factors exceeds the mixing due to momentum of the jet.

In the case of an extremely buoyant plume, or discharge close to the water surface, the plume may reach the air-water interface. Whenever this happens, the assumed geometry of the plume becomes semicircular, and the model proceeds with whatever mode of calculation it was in.

7.2.3.2 Model Inputs

The mathematical model described above can simulate many interesting physical cases depending on what input values are specified. A pictorial representation of the basic physical parameters is given in Figure 44. Conditions of interest include the two modes of operation (quench and scrubber), seasonal ocean conditions (summer and winter), and varying water currents (high and low) under otherwise nominal conditions. Figure 45 shows a parameter tree for this analysis. A second analysis takes the worst case from among these possibilities and investigates the sensitivity of pollutant concentration to changes in the ocean turbulence level, depth of injection, and angle of injection from the horizontal. Figure 46 shows a parameter tree for this second analysis.

Ocean Parameters

Varying currents are perhaps the most obvious effect that must be taken into account. Existing data are not detailed enough to use directly in the model, but the numbers in Table 29 help to choose arbitrary, yet realistic current profiles. A high level surface current was chosen based on the maximum observed, and a low level surface current to give a very "poor" case. Since no current data are available as a function of depth, an arbitrary profile shape was also constructed. A uniform current was

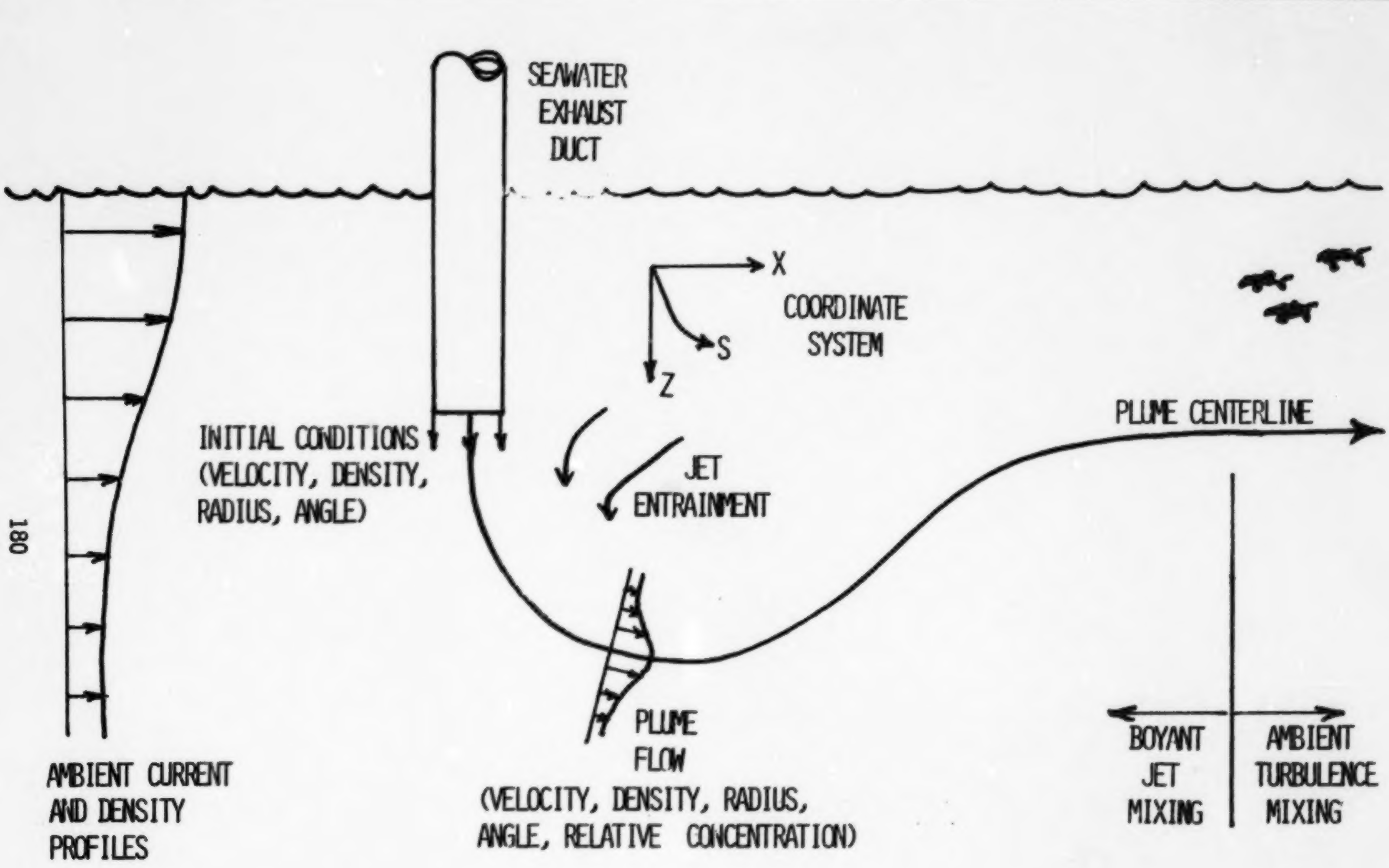

SEAWATER
EXHAUST
DUCT
X
S
Z
COORDINATE
SYSTEM
PLUME CENTERLINE
INITIAL CONDITIONS
(VELOCITY, DENSITY,
RADIUS, ANGLE)
JET
ENTRAINMENT
PLUME
FLOW
(VELOCITY, DENSITY, RADIUS,
ANGLE, RELATIVE CONCENTRATION)
AMBIENT CURRENT
AND DENSITY
PROFILES
BOYANT
JET
MIXING
AMBIENT
TURBULENCE
MIXING

Figure 44. Physical Representation for Direct Effluent Analysis

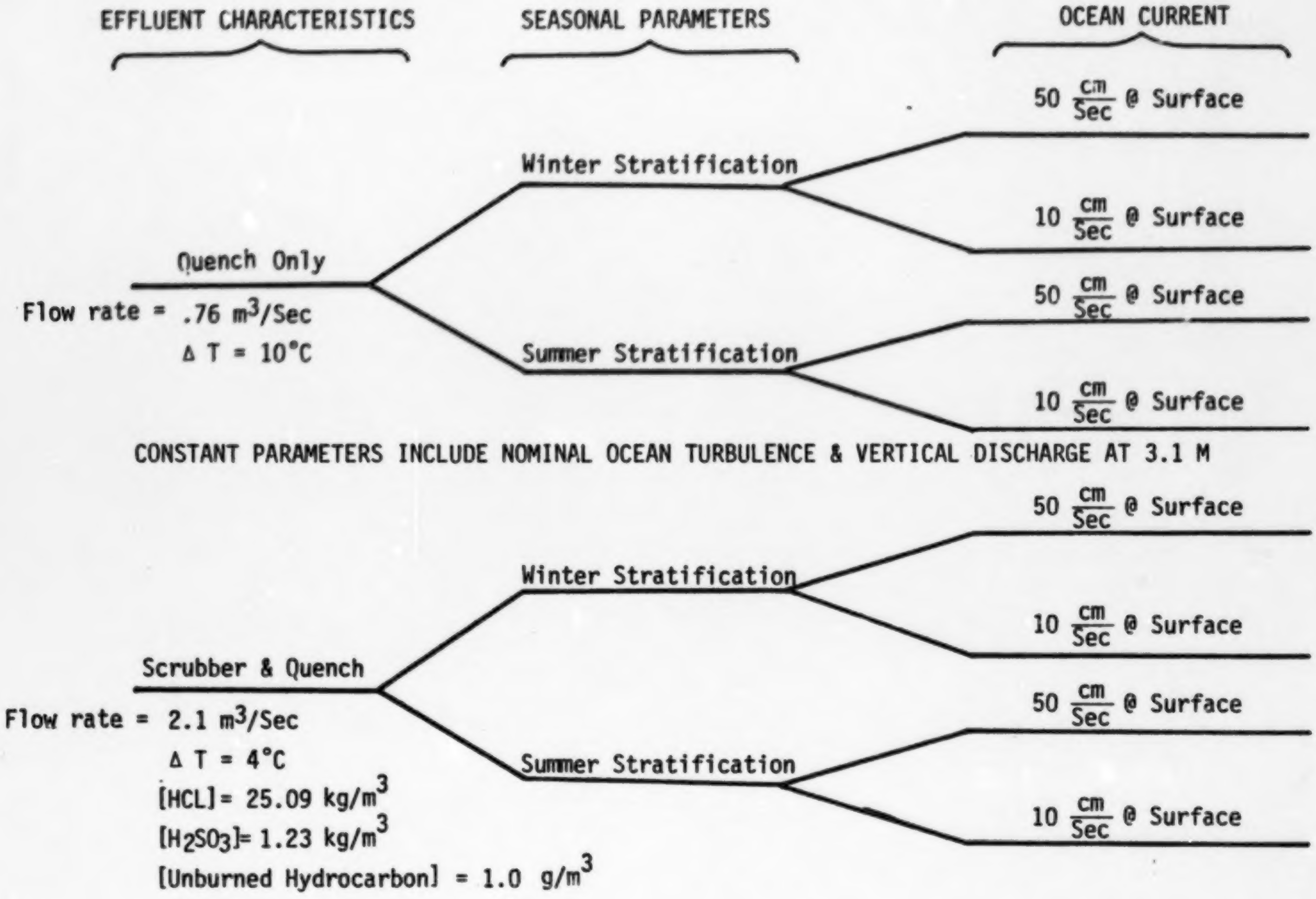
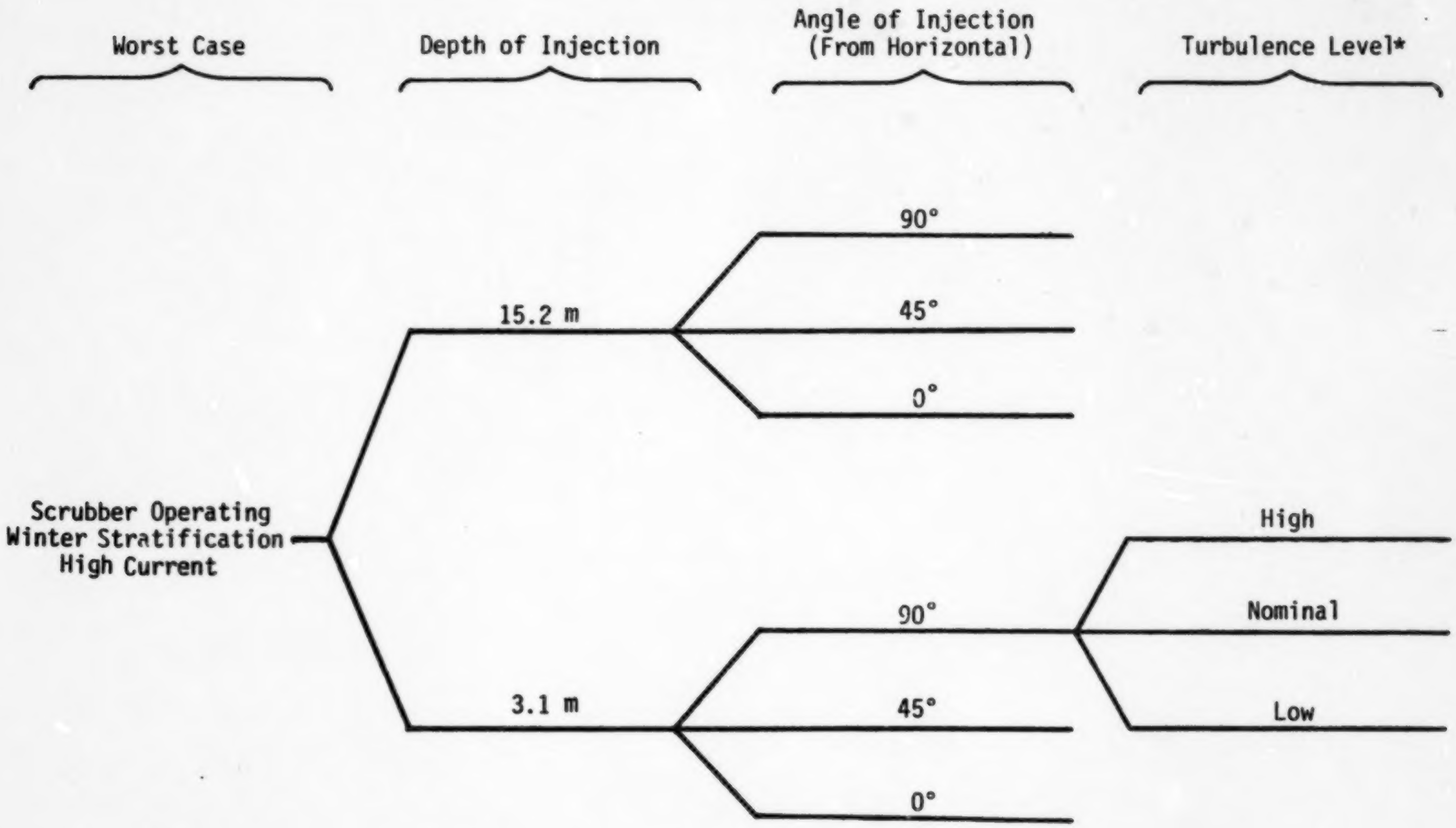

EFFLUENT CHARACTERISTICS
SEASONAL PARAMETERS
OCEAN CURRENT
Quench Only
Flow rate = .76 m^3/Sec
Δ T = 10°C
Winter Stratification
Summer Stratification
50 $\frac{cm}{Sec}$ @ Surface
10 $\frac{cm}{Sec}$ @ Surface
50 $\frac{cm}{Sec}$ @ Surface
10 $\frac{cm}{Sec}$ @ Surface
CONSTANT PARAMETERS INCLUDE NOMINAL OCEAN TURBULENCE & VERTICAL DISCHARGE AT 3.1 M
Scrubber & Quench
Flow rate = 2.1 m^3/Sec
Δ T = 4°C
[HCL]= 25.09 kg/m^3
[H_2SO_3]= 1.23 kg/m^3
[Unburned Hydrocarbon] = 1.0 g/m^3
Winter Stratification
Summer Stratification
50 $\frac{cm}{Sec}$ @ Surface
10 $\frac{cm}{Sec}$ @ Surface
50 $\frac{cm}{Sec}$ @ Surface
10 $\frac{cm}{Sec}$ @ Surface

Figure 45. Parameter Tree for Water Quality Simulation: Cases


Worst Case
Depth of Injection
Angle of Injection (From Horizontal)
Turbulence Level*
Scrubber Operating
Winter Stratification
High Current
15.2 m
3.1 m
90°
45°
0°
90°
45°
0°
High
Nominal
Low

*Based on world ocean data and reflected in choice of ambient diffusivity constant (K), reference 32

Figure 46. Parameter Tree for Water Quality Simulation: Sensitivity Analysis

TABLE 33. SEASONAL OCEAN INPUTS TO WATER MODEL

Depth (Meters)	Low Current (cm/sec)	High Current (cm/sec)	Density (g/cm^3)
Summer Case			
0	10	50	1.016
10	10	50	1.023
20	10	50	1.023
30	10	50	1.0243
50	1	2	1.0254
75	1	2	1.0258
100	1	2	1.0261
Winter Case			
0	10	50	1.0250
10	10	50	1.0250
20	10	50	1.0255
30	10	50	1.0255
50	10	50	1.0256
75	1	2	1.0264
100	1	2	1.0264

Source: Reference 26 (Current valves are assumed: See text) assumed down to the thermocline, where a drastic reduction in velocity may be expected, and very low values were chosen past that point. Since the thermocline level changes seasonally, the current profiles will also change. The level of the thermocline can be seen in Figure 43. All of this information is presented in Table 33.

Ocean turbulence is another important parameter. Generalized turbulence effects for the world's oceans have been discussed in the literature (32). A correlation of data points from many experiments show ocean turbulence to fall into a rather well defined range. This model accounts for low, nominal, and high turbulence levels.

Effluent Rates and Characteristics

The characteristics of the effluent will depend upon its chemical composition, the physical design of the discharge pipe, and on the mode of operation of the incineration system, i.e., quench or scrubber mode. Effluent initial velocity is calculated based on known liquid flow rates from the quench and scrubber and a given pipe diameter of 0.203 meters (8"). The density of the effluent depends on its temperature and salinity. These, in turn, depend upon the ambient surface temperature and salinity, the incremental temperature rise of the system in operation, and the extent of saline pollutant addition. By knowing the temperature and salinity of the effluent, its density can be determined from a mathematical relationship (33). All other parameters, including initial pollutant concentrations, are shown in Table 34.

The concentration of the pollutants from CMW in the effluent is based on the emission rates (Table 28), and scrubber flow rates, assuming 99, 90 and 50 percent scrubber efficiencies for HCl, SO_2 and unburned hydrocarbons, respectively.

It is not known what proportion of the unburned hydrocarbon is PCB. However, a worst case can be defined by assuming that it is all PCB, although this is unlikely.

TABLE 34. EFFLUENT CHARACTERISTICS FOR TWO MODES OF OPERATION

Parameter	Quench Mode	Scrubber Mode (with quench)
Pipe Radius	.203 meters (8")	.203 meters (8")
Effluent Flow Rate	45.4 m^3/hr	125 m^3/hr
Discharge Velocity, U	0.453 m/sec	1.746 m/sec
ΔT of Effluent	10°C	4°C
For CMW Waste:		
(Cl^-) added	-	24.4 kg/m^3
($SO_3^=$) added	-	1.2 kg/m^3
(unburned hydrocarbon)	-	1.0 g/m^3
(particulate)	-	70-750 g/m^3
ΔS (salinity) of effluent	-	25.6 ppt
Effluent:		
Temperature (summer)	41°C	35°C
Salinity (summer)	28 ppt	53.6 ppt
Density (summer)	1.01234 g/cm^3	1.03394 g/cm^3
Temperature (winter)	31.2°C	25.2°C
Salinity (winter)	35.7 ppt	61.3 ppt
Density (winter)	1.02163 g/cm^3	1.04350 g/cm^3

7.2.3.3 Results

Table 35 summarizes absolute concentrations and temperature impacts for a number of cases 24 meters from the point of effluent discharge.

Major conclusions from the parametric analysis are as follows:

- High currents give higher concentrations in the wintertime.
- Low currents give higher concentrations in the summertime.
- For the waste studied, the worst case occurs with the scrubber operating in the wintertime and high current.
- These results may differ for effluents of different density.
- Lowering point of discharge has no effect on absolute concentrations but increases the depth at which impact occurs.
- Angling discharge pipe lowers overall concentrations. Effect of 0° and 45° angles are essentially the same.
- High ocean turbulence improves mixing in the far field but may inhibit mixing in near field.

Major recommendations are as follows:

- Increase exit velocity of quench to minimize near field temperature effects.
- Angle pipe outlet 45° in direction of current to increase plume depth.
- Increase discharge pipe length if additional plume depth is required.

The results of the water quality simulation were found by first running the cases shown in Figure 45. Then one of these cases was choser as a worst case situation. This decision was made as objectively as possible by establishing the pollutant concentrations at 24 meters as a common criterion for comparison. Once chosen, this case served as a baseline for the sensitivity analysis of Figure 46. In this way, the sensitivity of the entire system to changes in a certain parameter could be seen. These parameters are largely concerned with the physical configuration of the outfall pipe, so that some design recommendations were possible. All results are shown graphically in Figures 47 through 57. Each pair of graphs shows relative concentrations along with centerline of the plume and the depth of the plume below the water surface for a given case.

Figures 47 through 50 show the results of the first set of cases. An immediate observation is that the low current cases show higher con-

TABLE 35. POLLUTANT CONCENTRATIONS AND TEMPERATURE RISE AT 24 METERS ALONG CENTERLINE OF PLUME FOR DIFFERENT CASES

Case			Dilution Factor	(Cl^-) kg/m^3	$(SO_3^=)$ kg/m3	(unburned Hydrocarbon) g/m^3	ΔT°C
Scrubber	Winter	High Current	.017	.41	.02	.017	.1
		Low Current	.004	.10	.004	.004	.02
	Summer	High Current	.011	.27	.01	.011	.04
		Low Current	.016	.39	.02	.016	.06
Quench	Winter	High Current	.018	-	-	-	.2
		Low Current	.003	-	-	-	.03
	Summer	High Current	.016	-	-	-	.2
		Low Current	.027	-	-	-	.3

NOTE: Possible interactions between primary pollutants and aquatic environment, such as effect on BOD, have not been evaluated.

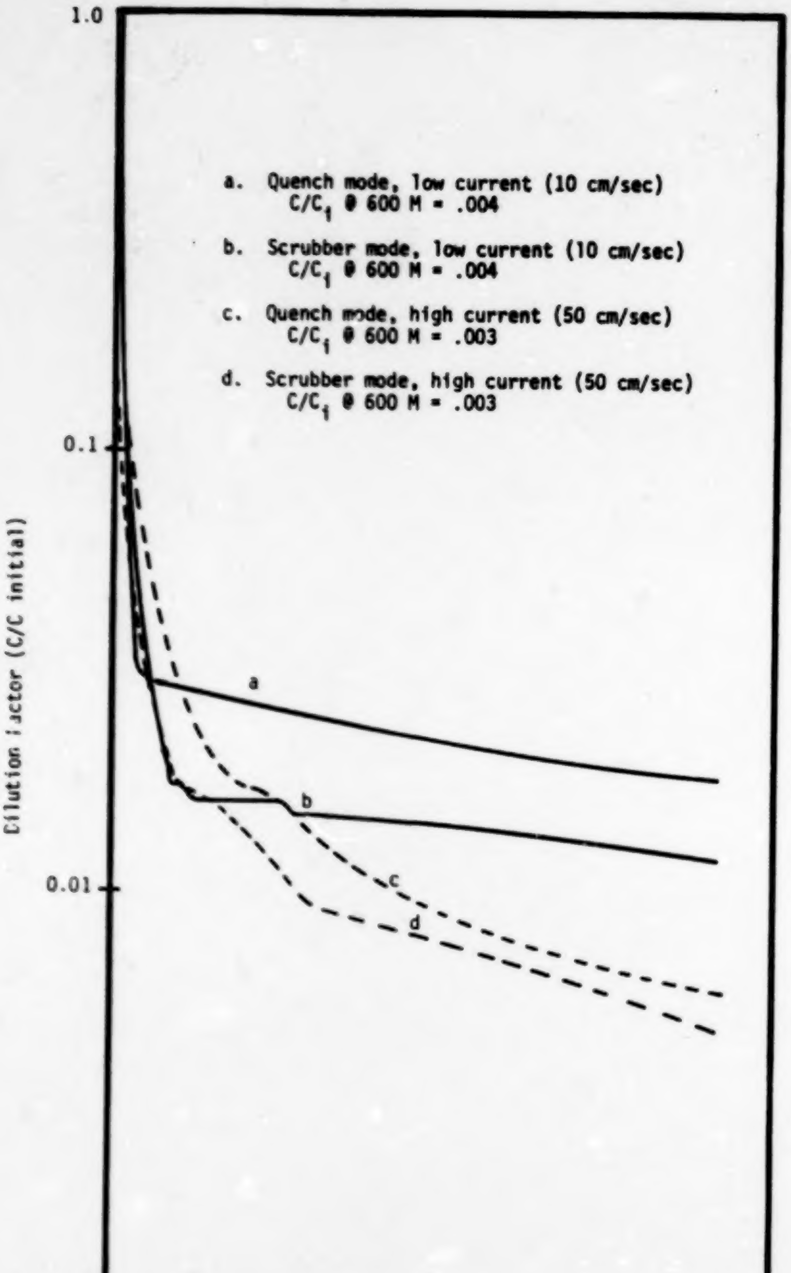


Figure 47. Variation of Water Quality Concentration With Distance in Summer

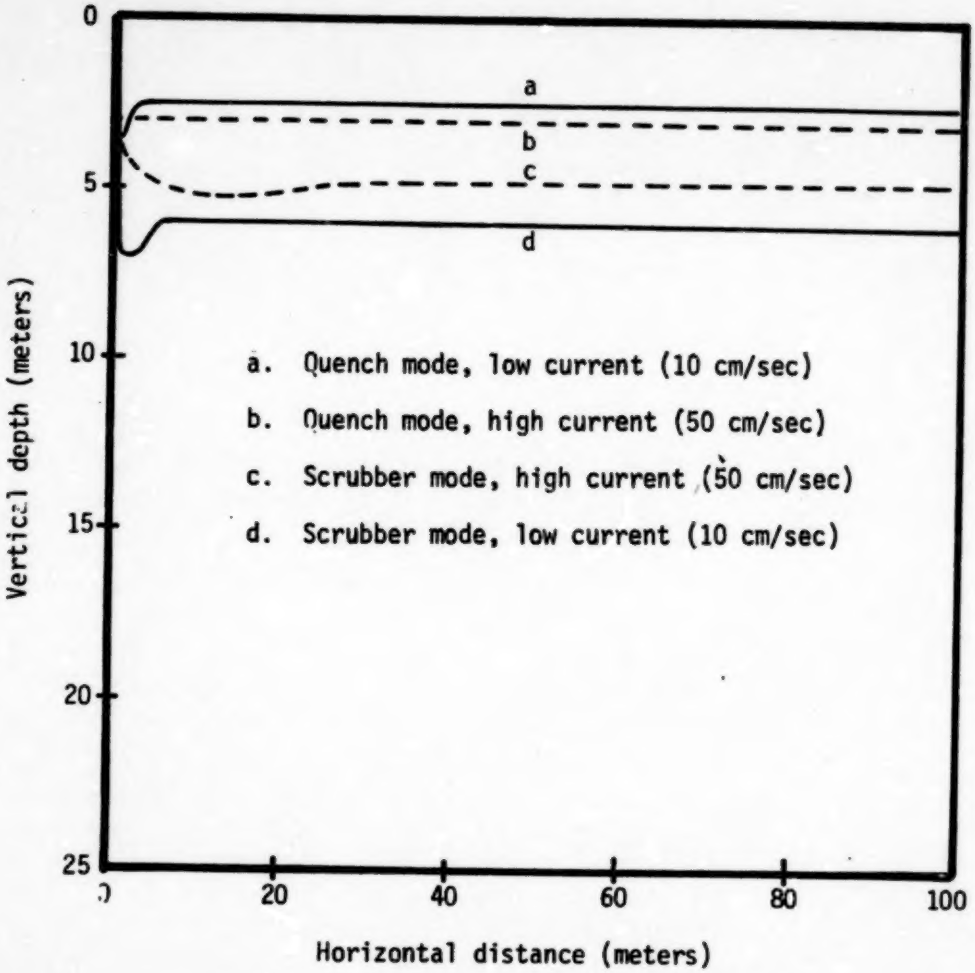


Figure 48. Liquid Effluent Plume Centerline Profile During Summer

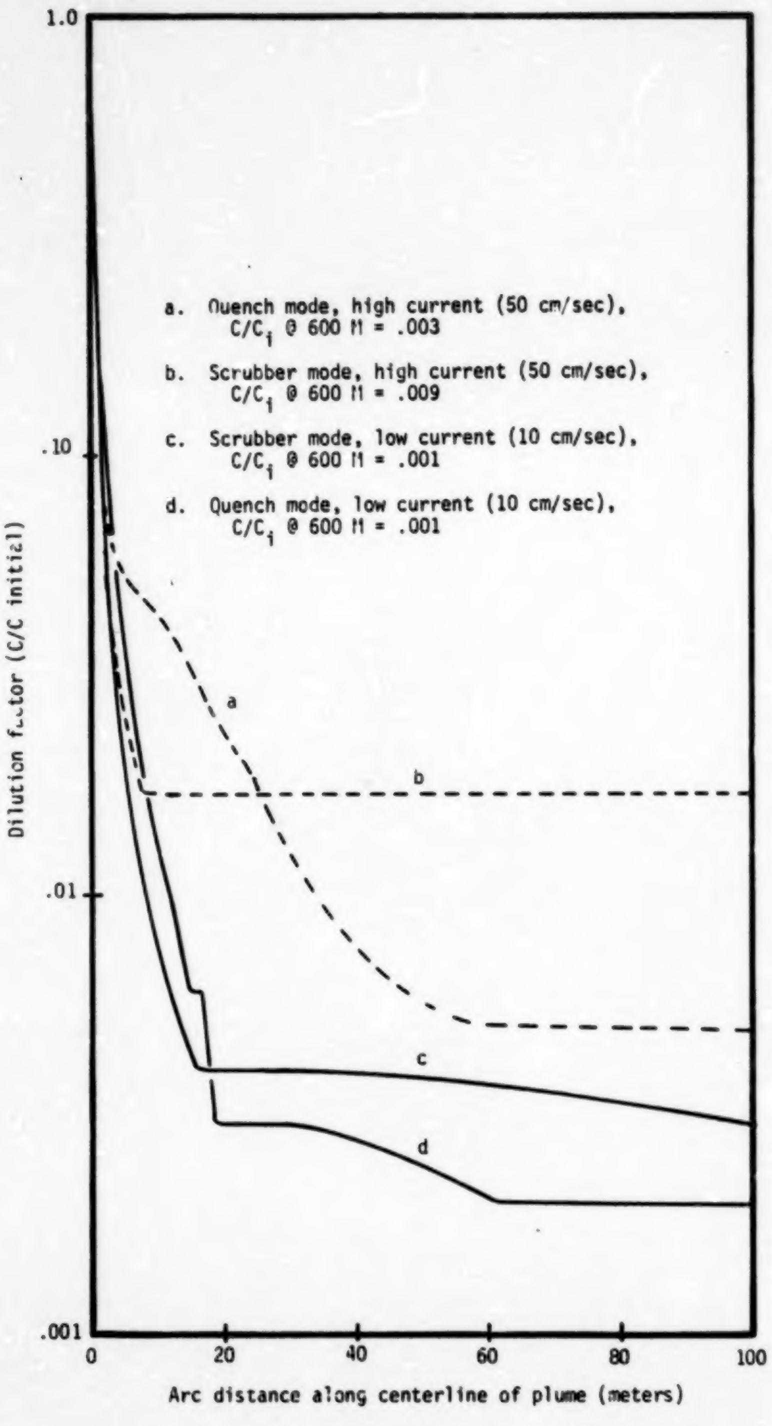


Figure 49. Variation of Water Quality Concentration With Distance in Winter

a. Quench mode, low current (10 cm/sec)

b. Quench mode, high current (50 cm/sec)

c. Scrubber mode, high current (50 cm/sec)

d. Scrubber mode, low current (10 cm/sec)

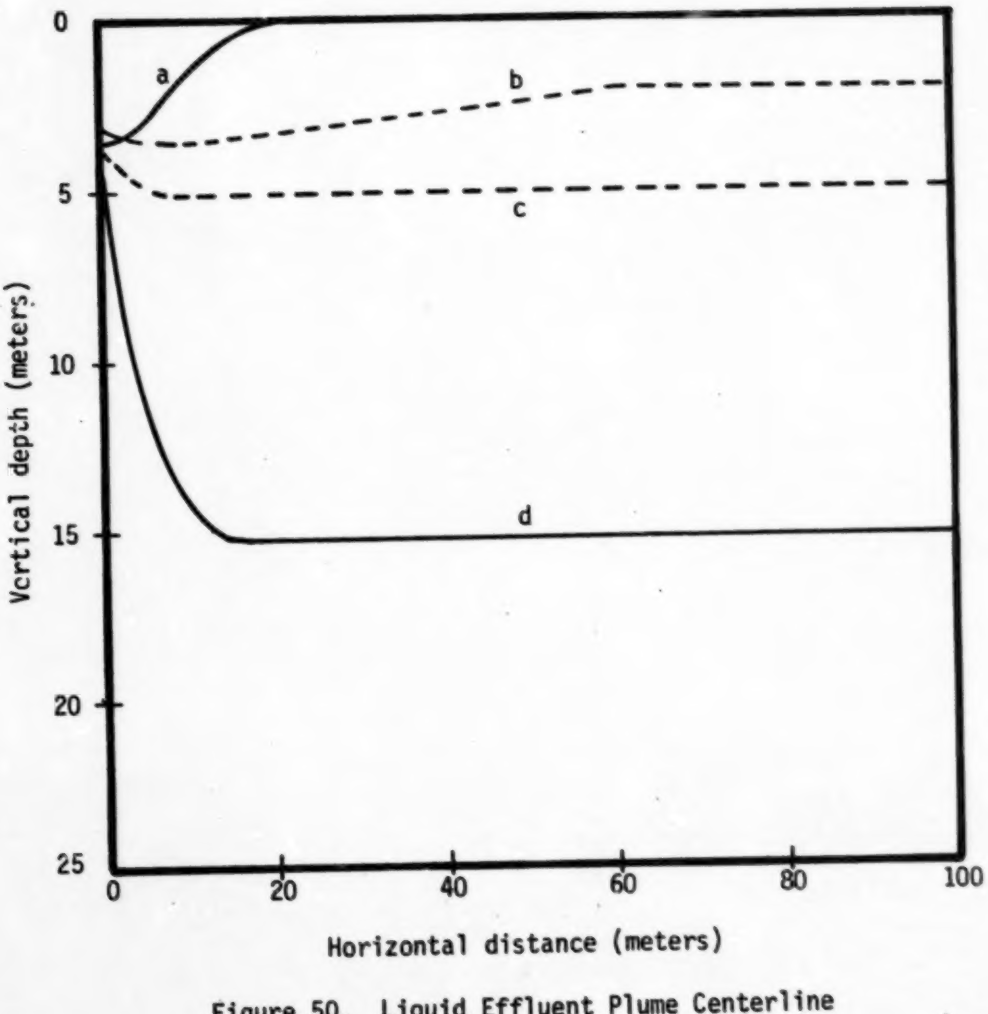
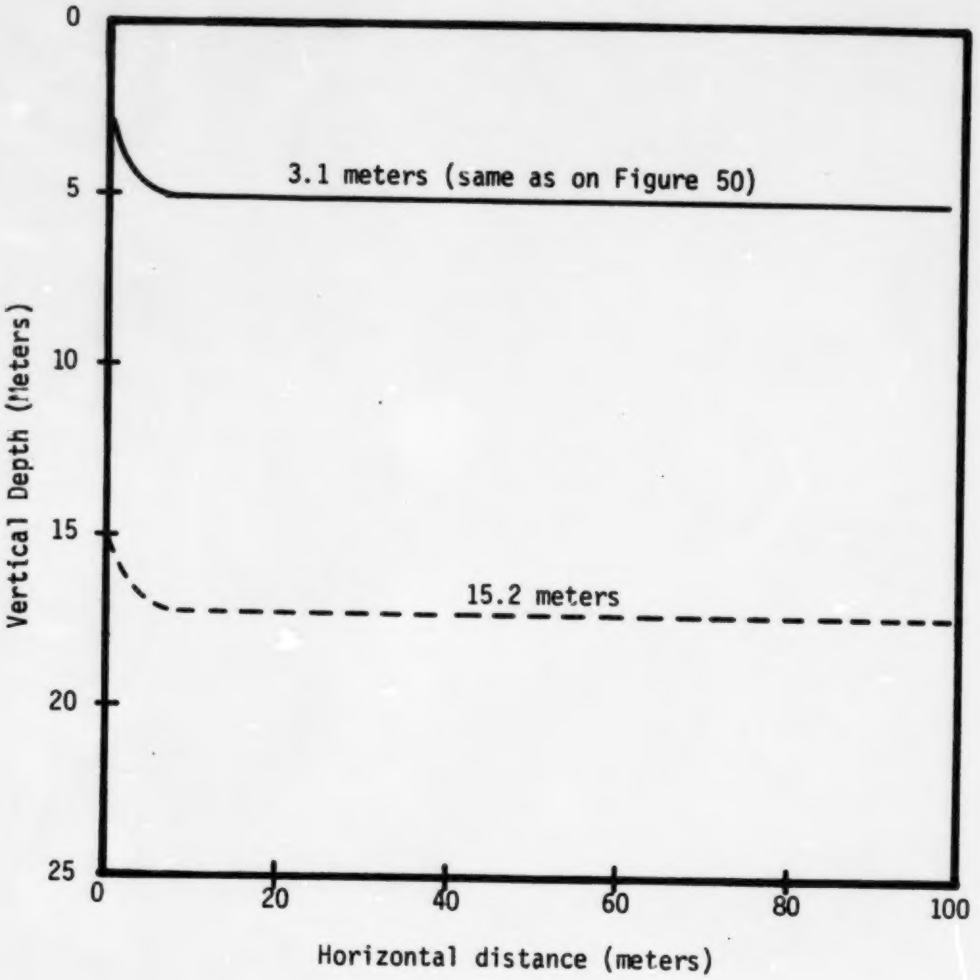


Figure 50. Liquid Effluent Plume Centerline Profile During Winter



NOTE: Concentration curves for these two cases are identical, see Figure 49.

Figure 51. Comparison of Discharge Depths for Scrubber Mode Operation During Winter High Current

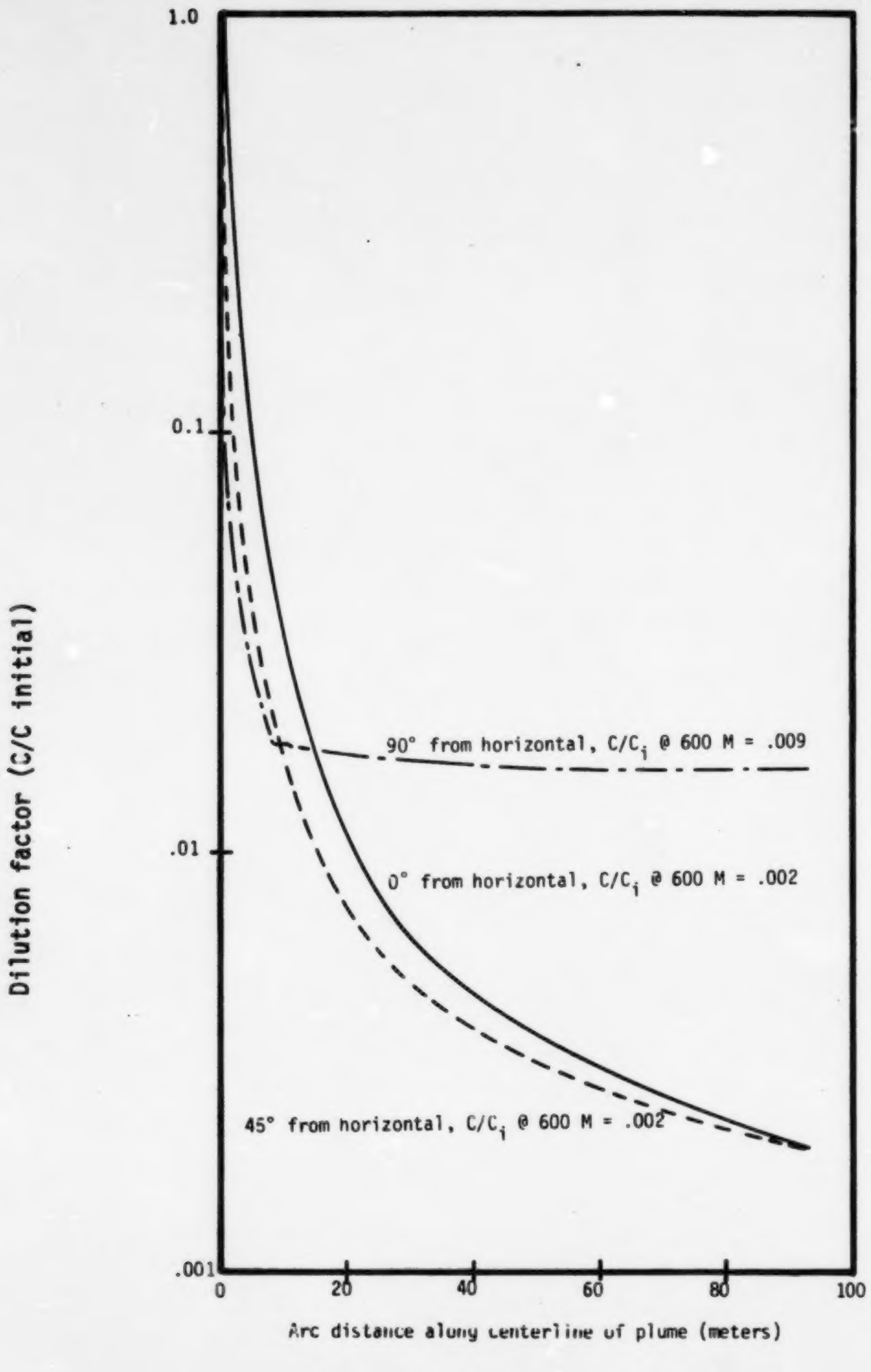


Figure 52. Comparison of Discharge Angles for 15.2 Meter Injection Depth: Scrubber Mode Operation During Winter, High Current

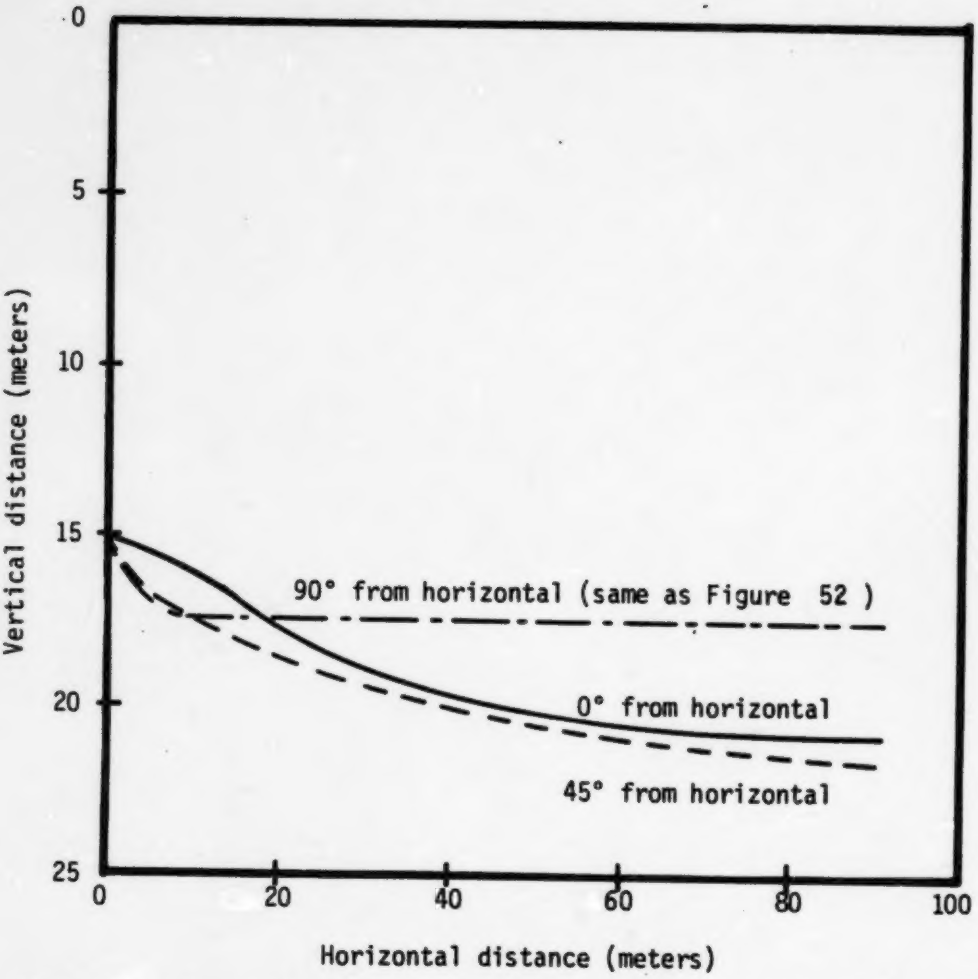


Figure 53. Comparison of Discharge Angles from 15.2 Meter Injection Depth: Scrubber Mode Operation During Winter, High Current

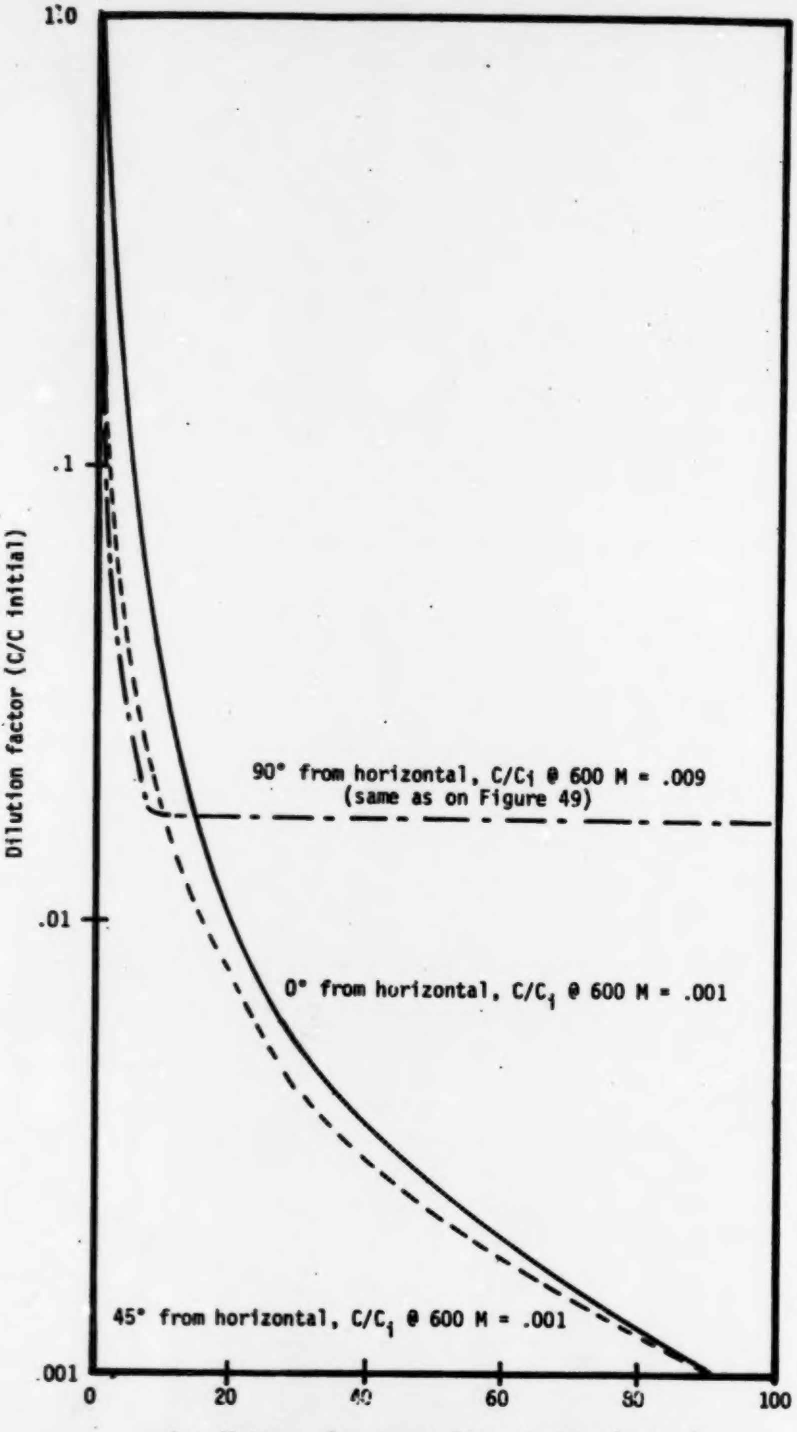


Figure 54. Comparison of Discharge Angles for 3.1 Meter Injection Depth: Scrubber Mode Operation During Winter High Current

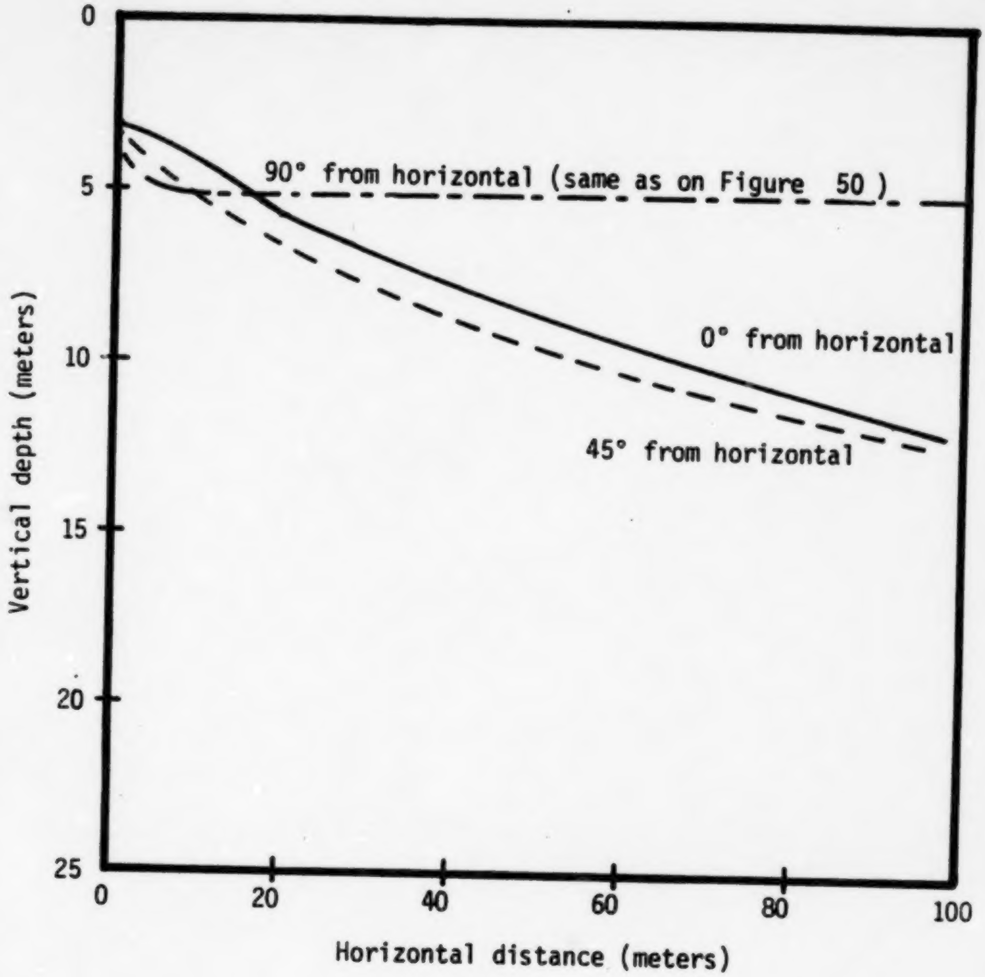


Figure 55. Comparison of Discharge Angles for 3.1 Meter Injection Depth: Scrubber Mode Operation During Winter High Current

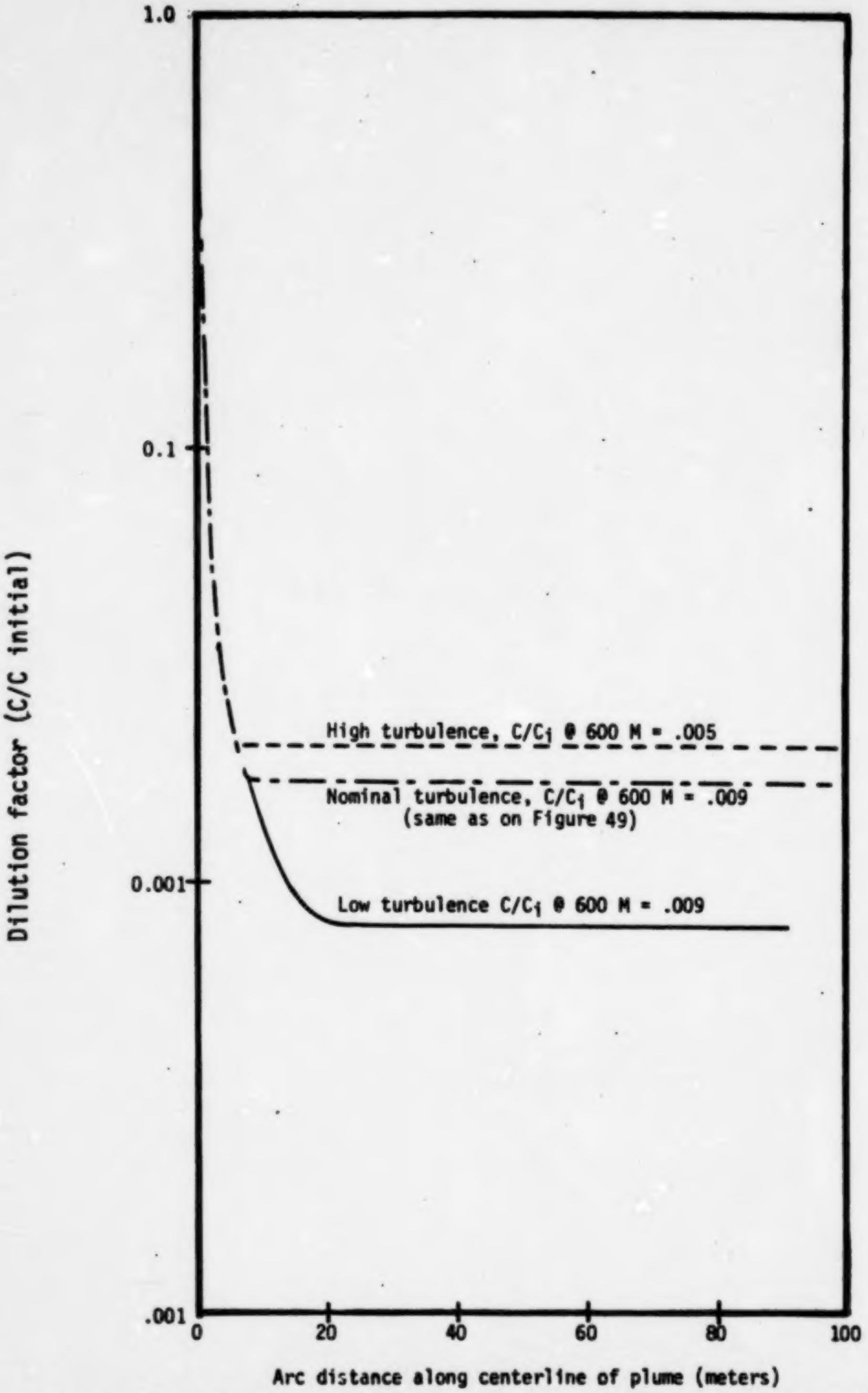


Figure 56. Comparison of Turbulence Levels for 3.1 Meter Injection Depth, 90° from Horizontal: Scrubber Mode Operation During Winter High Current

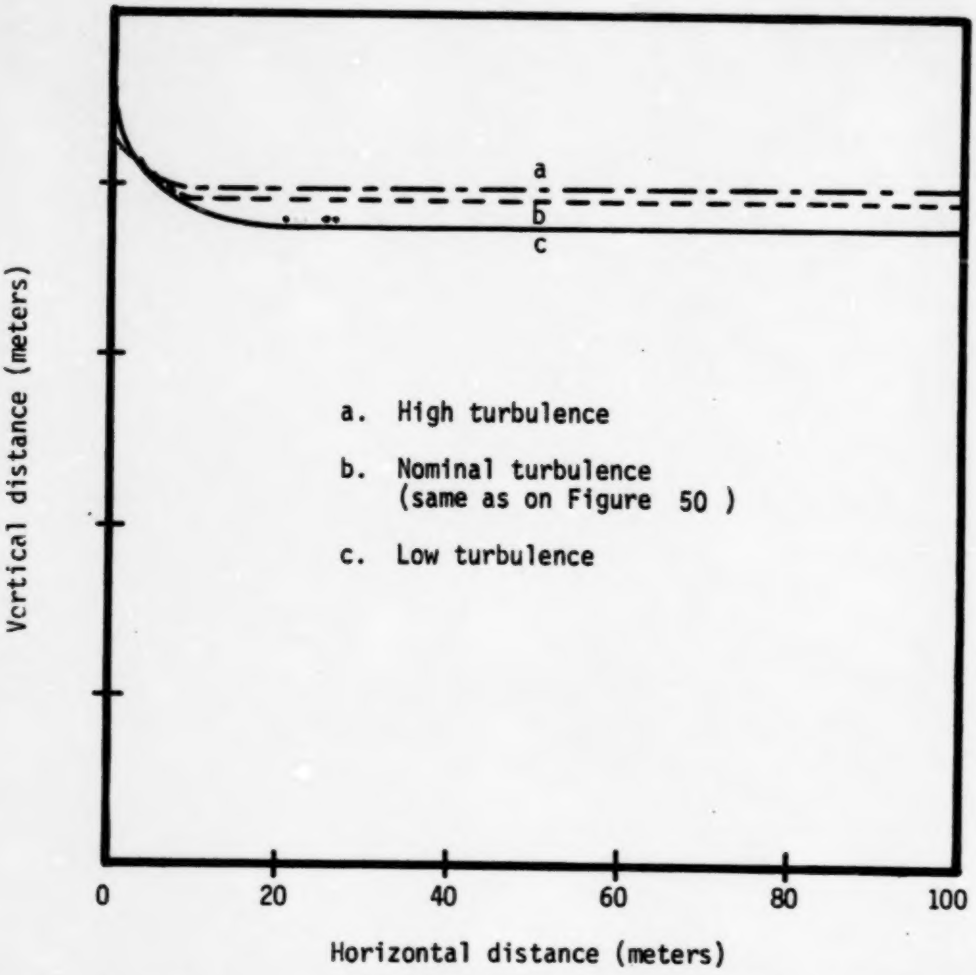


Figure 57. Comparison of Turbulence Levels for 3.1 Meter Injection Depth, 90° from Horizontal: Scrubber Mode Operation During Winter High Current

centrations during the summer, but the high current cases show higher concentrations during the winter. The only exception is seen in Figure 47, where operation during the summer in high currents produces higher concentrations in the near field. It should be noted, however, that although the concentrations very close to the discharge pipe are high, only a small volume of the aquatic environment is exposed to such levels. The intermediate and far fields cover a much larger volume due to expansion of the plume, and should be considered more seriously. For this reason, the low current case in Figure 47 is considered ecologically worse than the high current case. Also, the original observation leads to the most realistic cases, since currents tend to be higher in the winter (see Figure 36). Plots showing the plume centerline trajectory for each case are included because this information may be important in terms of the biological communities to be found at different levels.

Concentration was used as the single criterion for choosing the worst case. Table 35 presents absolute concentrations of chloride ion, sulfite ion, and unburned hydrocarbon as well as the temperature rise at a distance of 24 meters along the arc length of the plume. This distance was chosen because it is the point where most of the plumes seem to have become well equilibrated in terms of their vertical movements. These absolute concentrations were found by:

absolute concentration = dilution factor X concentration of constituent at effluent.

The temperature along the plume was found by the following equation:

T = T ambient + (T initial effluent - T ambient) X dilution factor

Temperatures may be given in °C or °F. It should also be noted that the dilution factors given in the figures are only valid for the particular waste analyzed, since different wastes will have different densities and this is an important input parameter of the model.

Table 35 showed that the quench mode yields the poorest dilution factors. This is probably due to the lower initial momentum of the quench effluent. However, the scrubber effluent contains the actual pollutants of interest, and even though the quench mode has a slightly higher thermal impact, this is not considered significant at this distance. The worst case was therefore chosen as the highest set of concentrations from the scrubber effluent. This turned out to be the winter case, with high current.

Some early trial runs of this model assumed a waste of much lower density. Interestingly, this modification showed that the worst case would occur in the summer during periods of low current. This observation showed that wastes of different density could give very different results. The interaction of many seasonal conditions provides a complicated relationship which is not necessarily intuitive.

Once a worst case was chosen, the parameters outlined in Figure 46 were varied to determine their effect on the given situation. The results of these cases are presented in Figures 51 through 57.

The first of these was simply a view of what happened when the depth of outfall was increased. The effect was to increase the depth of the plume by this amount. The concentrations along the arc length of the plume were identical in both cases (see Figure 51).

Figures 52 through 55 show what happens when the angle of discharge is altered. The three angles used are 0°, 45°, and 90°, and two different discharge depths are also used here. As before, the increased depth produces very similar concentration distributions, but somewhat different centerline profiles are obtained. Using a 45° or 0° discharge angle on a short pipe could significantly increase plume depth. Both in terms of concentration and profile, the 45° and 0° cases behave similarly. It should be pointed out that these pipes must be angled in the direction of the current for such results.

Finally, Figures 55 and 57 show the results of varying ocean turbulence levels. The turbulence constants used in this model were derived from world ocean data. Since the Gulf of Mexico is a relatively low energy system, the low and nominal levels presented here may be the most realistic examples. From Figure 56 it can be seen that high turbulence actually inhibits the buoyant jet mixing in the near field. The high level of random motion acts to reduce the momentum of the plume. However, the higher turbulence aids the ambient mixing process, so that far field concentrations actually became lower than with the low or nominal turbulence levels.

Recommendations concerning the design of the outfall pipe can be made from these observations. First, the dilution factors for the quench system can be improved by increasing the effluent exit velocity from this system. Large enough temperature increases in the near field may warrant this action. Also, consideration for the nature of the local biology may suggest that surface plumes should be avoided. Increasing pipe length can produce these results. Angling the point of outfall from 90° to the horizontal to 45° will produce a sizeable increase in depth. Since the effects of 45° and 0° angles with the horizontal are essentially the same, the 45° angle should be chosen for lower frictional losses.

7.2.4 Plume Touchdown

This section addresses the problem of how air pollutants generated by the incinerator enter the aquatic environment. This occurs whenever the airborne plume touches the surface of the ocean. Constituents of the plume will then be dissolved into the water. A methodology for estimating the rate of this mass transfer and the resulting maximum aqueous concentration is presented. The conditions chosen represent the worst situation likely to occur. Therefore, they can be considered a reasonable worst case.

7.2.4.1 Description of Model

The physical situation to be modeled is very complicated, largely because there are no obvious boundaries to the problem. Mass transfer is taking place from the plume to the water, but the width of the plume cannot be easily identified, and neither can the volume of water being affected. However, some limits must be arbitrarily set in order to calculate absolute concentrations in the water. For this reason, a one meter cube of water was chosen as the volume to be studied. Since the highest concentrations occur at the centerline of the plume, a cube traveling directly under this line represents the worst case. This also simplifies the calculation to consideration of only one dimension, and eliminates the problem of defining the width of the plume.

The one meter cube is assumed to travel at the surface of the water at a velocity of 10 cm/sec, which is a very low, but plausible, value for the platform area. Higher concentrations result with lower current speeds since the mass transfer takes place over a longer period of time. Although the dissolved gases will always be diffusing out of the hypothetical cube, if the cube is assumed to be in a larger area of homogeneous concentration, these effects will be minimized. This is approximately true since the cube spends most of its time in the center of the total volume of water being affected. Therefore it can be assumed that no transfer takes place across the aqueous boundaries of the cube.

Deposition of airborne material is treated by the following relationship:

$$D = KX,$$

where X is the surface concentration of the airborne constituent, K is a mass flux coefficient (units of L/T), and D is the total rate of mass flux. K varies for different mechanisms of deposition, i.e., wet and dry deposition, and may also vary for the different constituents being considered (34). For dry deposition, the gases are assumed to be perfectly absorbed into the water. For low molecular weights, K = 1 cm/sec is an accepted literature value. For high molecular weights, the expression:

$$K = \alpha^{-1}(.03\ U)/(\nu/D)^{2/3}$$

is used to find K. The constants are: solubility coefficient (α), mean wind speed (U), kinematic viscosity of the air (ν), and the molecular diffusivity in air of the gas being considered (D). For wet deposition:

$$K = \alpha p_0$$

is used. The volume flux of water due to precipitation is given by p_0, and α is the solubility constant of the particular gas being considered. This entire discussion on K values was taken from Reference 34. Assumptions inherent in this methodology are outlined in Table 36.

7.2.4.2 Values used in the Analysis

To actually perform the calculation, the case of D stability, 20°C ambient temperature, 5.5 cm/sec wind speed, and a 15.2 meter stack height was chosen. This represents the worst case from the point of view of plume touchdown because a maximum distribution of air pollutants is available for

TABLE 36. ASSUMPTIONS OF PLUME TOUCHDOWN MODEL

- Amount of mass transfer is directly proportional to concentration in the gas phase.
- Air pollutants are generated by an infinite source.
- Plume retains steady state after touchdown.
- Problem is bounded by a 1 m^3 cube in the liquid phase traveling underneath the centerline of the plume.
- Cube is contained in a larger volume of homogeneous concentration so that liquid diffusion can be ignored.
- Gases are perfectly absorbed in the dry deposition case.

TABLE 37. INPUT CONDITIONS FOR PLUME TOUCHDOWN ANALYSIS

Baseline Conditions:

Stability Class = D
Stack Height = 15.2 meters
Ambient Temperature = 20°C
Ambient Pressure = 1 ATM
Nominal Wind Speed = 5.5 m/sec

Pollutant Flow Rates at Stack:

HCL $\dot{Q}$ = 542.5 g/sec
SO_2 $\dot{Q}$ = 21.08 g/sec
PCB $\dot{Q}$ = 0.004 g/sec

Solubility Coefficients:

HCL α = 71.4
SO_2 α = 26.3

PCB α = 41.7

Miscellaneous:

$\nu = 1.509 \times 10^{-5}\ m^2/sec$
$D = 4.8 \times 10^{-6}\ m^2/sec$ (assuming PCB with four chlorine atoms)
Typical Heavy Rainfall = 15.2 cm
Assumed Duration = 28 hours
$p_0 = 1.4 \times 10^{-4}$ cm/sec
Time cube spends under 1000 meter interval = 10,000 sec.

transfer across the ocean surface. The straight line path of the cube was divided into a series of 1000 meter intervals. At each interval a new mass flux rate (D) was calculated and assumed to be constant over the interval. This value was then multiplied by the amount of time the cube spent in the interval. Thus, the absolute mass of constituent deposited in each interval was obtained. A summation of these values over the region of interest provided a rough integration of the cube's absolute concentration. These values were obtained for SO_2, HCl, and PCB for both the wet and dry deposition mechanisms. The volume flux of precipitation for K's in the wet deposition case was found by taking a typical heavy rainfall (25) and dividing this volume by the total time the cube traveled under the plume. Other constants can be found from a standard chemical reference (25). All input values are listed in Table 37.

7.2.4.3 Results

The results of the plume touchdown analysis are shown in Table 38 in terms of the K values and the maximum absolute concentrations. These are given for HCL, SO_2, and PCB for both the wet and dry deposition mechanisms. Water quality concentrations at a distance of 10,000 meters downwind from the platform are shown. Concentrations in the plume fall off rapidly past this point, and any additional material transfer would not be significant. This also means the current is moving away from the platform.

Major conclusions of the analysis are as follows:

- Concentrations of HCL and SO_2 are not high enough to seriously alter pH or chlorinity. Secondary effects such as BOD response are not considered.
- PCB concentrations may be significant, compared to the minimum acute toxicity effluent (MATE) value for PCB (0.005 ppb) (36).
- Wet deposition is not a significant mechanism for removal of gases from the plume compared to dry deposition.

TABLE 38. RESULTS OF THE PLUME TOUCHDOWN ANALYSIS

QUANTITY	POLLUTANT HCL	 SO_2	 PCB
K for dry deposition	1.0 cm/sec	1.0 cm/sec	0.7 cm/sec
K for wet deposition	0.01 cm/sec	0.004 cm/sec	0.006 cm/sec
Absolute concentration @ 10,000 meters	0.58 mg/l	0.023 mg/l	0.003 µg/l or .003 ppb

ORGANIZATIONS AND INDIVIDUALS CONTACTED

1. Charles Chapel, National Oceanic and Atmospheric Administration (NOAA), Boulder, Colorado.
2. Data Buoy Office, NOAA, Bay St. Louis, Mississippi.
3. John Erwin, Meteorology and Assessment Division, Environmental Sciences Research Laboratory, Environmental Protection Agency, Research Triangle Park, North Carolina.
4. Frank Gifford, Oak Ridge National Laboratory, Oak Ridge, Tennessee.
5. William Goodin, Dames and Moore, Los Angeles, California.
6. Commander Robert Hammond, Marine Services, U. S. Coast Guard, Washington, D. C.
7. Alan Huber, Office of Air Quality Planning and Standards, EPA, Durham, North Carolina.
8. Institute for Storm Research, University of St. Thomas, Houston, Texas.
9. National Climatic Center, Asheville, North Carolina.
10. National Hurricane Center, Miami, Florida.
11. National Weather Service, New Orleans, Louisiana.
12. National Weather Service, Silver Spring, Maryland.
13. Gilbert Raynor, Brookhaven National Laboratory, Upton, New York.

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APPENDIX A

STRUCTURAL

EPA OFFSHORE PLATFORM

PRELIMINARY STRUCTURAL LOADING CRITERIA

The purpose of this document is to present preliminary structural loading criteria for the EPA Offshore Platform project. The platform in question is Chevron's MP 254A (Main Pass field, Block 254, Structure A) abandoned oil rig located approximately 60 miles due south of Mobile, Alabama. Of primary concern in the investigation is the wind loading conditions and the dead load (DL) and live load (LL) criteria. Secondary consideration is given to sizing data and is presented when available. Lateral loads due to seismic action (Alabama is in Zone 0 on the ICBO's UBC, '76 ed. Seismic Risk Map, which represents No Damage) and snow loads (winter night time ambient temperatures in the 50° F's) are considered to be non-existent.

WIND LOADING CRITERIA

In talking to Mr. Bob Smyly (Architect for the Alabama Building Commission, Montgomery, Alabama, Phone: 205-832-3404) he stated that for coastal building design they use a 110 mph wind velocity and a cylindrical shape factor of 0.7. In their design they use the 1978 edition of the South-East Region Uniform Building Code (UBC). Information on the 1979 edition and additional data was obtained from Mr. Bill Tangye (Chief Engineer, Southern Code Congress, 900 Montclair Road, Burmingham, Alabama, 35213, Phone: 205-591-1853, a copy can be purchased for $16.50). Mr. Tangye also stated that 110 mph wind velocity is standard for coastal conditions and suggested for a 60 miles offshore platform a 120 mph wind velocity could be considered. Unofficial winds of 130 to 150 mph were reported with the recent Mobile, Alabama hurricane (official wind data can be obtained from Mr. Bill Skinner, National Climatic Center, Asheville, North Carolina, Phone: 704-258-2850 ext 683, a cost of $15.00 per station reading is available and September data will be published at the end of October 1979).

From the Standard South-East Building Code, '79 edition, the following formula was given by Mr. Tangye and converts wind velocity into wind pressure;

$$P = 0.00256\, V^2 \left(\frac{h}{30}\right)^{2/7}$$

where,

P = wind pressure, PSF
V = wind velocity, MPH
h = structure height, feet

For the EPA Platform the wind velocity nor height has been selected as yet. The following table gives wind pressure data for variable velocity and heights.

WIND PRESSURE, PSF

VELOCITY, MPH

h, FT.	110	120	130	140	150
0	30.98	36.86	43.26	50.18	57.60
70	39.60	47.13	55.31	64.15	73.64
80	41.17	48.99	57.50	66.68	76.55
90	42.60	50.70	59.50	69.00	79.21
100	43.92	52.27	61.34	71.14	81.67
110	45.15	53.73	63.06	73.14	83.96
120	46.15	55.11	64.46	74.76	85.82
130	47.40	56.40	66.19	76.78	88.13
140	48.43	57.62	67.62	78.44	90.04
150	49.26	58.61	68.78	79.79	91.58

It is noted that when using this table the height is taken from sea level. In this case the platform deck is approximately 70 feet above sea level and must be included in the calculations.

From the 1976 edition of the ICBO Standard Uniform Building Code published by the International Conference of Building Officials (ICBO, 5360 South Workman Mill Road, Whittier, CA 90601) the following wind pressures are given for the Alabama area (on the Wind Pressure Map, Alabama has a 50 Area Value):

h, feet	P,PSF
< 30	40
30 - 49	50
50 - 99	60
100 - 499	75

Using these values and the South-East UBC, '79 edition wind pressure equation, wind velocities in the 130 to 140 mph range are determined. Thus, wind velocities above 120 mph is not unrealistic for the design criteria.

The ICBO's UBC, '79 edition also gives a 0.7 shape factor for cylindrical structures which is identical to the South-East UBC. For uplift the following data is given in the ICBO's code:

a. For enclosed buildings = 0.75P
Net uplift force = (0.75P - DL) x roof area

b. For unenclosed buildings = 1.25P
Net uplift force = (1.25P - DL) x roof area

c. For eves and projections = 1.25P
Net uplift force = (1.25P - DL) x roof area

Based on the above data and discussions, it is not out of the question to use wind velocities from 130 to 150 mph and a cylindrical shape factor of 0.7. It is recommended that these higher values be used along with the wind pressure equation of the South-East UBC, 1979 edition. The design of the incenerator stack will obviously be the lead item and most critical of all the systems. It is suggested that not only rigid and break-away designs be investigated, but also guy wires with an attachment ring. The ring could be located near the top or 1/3 point of the stack with guy wires coming down and attaching to the steel deck, hard rail and/or top of buildings in order to avoid obstruction from day-to-day operations. It is further recommended that all on deck tanks be strapped securely and an enclosed cradle structure be considered to reduce uplift. If uplift is not a problem, then open skids or similar steel mounting devices will be adequate.

DEAD AND LIVE LOADING CRITERIA

Dead loads for the given systems are obtained from the most current data and is subject to change. Live loads are obtained from the ICBO's UBC, '76 edition. The systems considered do not include the existing offshore platform super structure nor the existing steel deck. The systems included in the feasibility study are listed as follows:

Incinerator
Crane
Living Quarters
Heliport
Control Center
Deck Storage, Staging and Cleaning Area
Potable Water System
Sanitary Sewage System
Seawater System
Fuel Storage (4 tanks) and Supply System
Compressed Air System
Electrical Power System (includes diesel generators)

Incinerator type has not yet been determined. Assuming the thermal reductor system with rotary kiln is selected the following data is applicable:

Capacity = 1500 lb/hr
Weight = 223,000 lb
Size = 18-3/4' W x 18-1/2'H x 41'LG
Stack Ht. = 50'
Stack Dia. = 2'Ø @ top and 3'Ø @ bottom

Crane data is very preliminary.

Capacity = 40,000 lb
Boom = 60' to 100'
Weight = 200,000 lb
Base = 20' x 20'

Living Quarters dead load and size is not available at this time. Live loads are determined from the ICBO's '76 edition Section 2304 (Unit Live Loads) and Table No. 23-A (Uniform and Concentrated Loads) as shown below:

	LL, PSF
Roof (Flat or Rise $<$ 4 inches per foot)	20
Bedrooms, Restrooms	40
Lounge/Recreation, Dining, Kitchen, Hall, Decontamination Rooms, Offices, Laboratory	50
Shop, Stairways and Landings	100
Storage Areas - Light	125
Storage Areas - Heavy	250

Heliport dead load will be determined by type of helicopters and anticipated payloads. The structure could be designed based on criteria from the ICBO's UBC, '76 edition Section 2315 (Heliport and Helistop Landing Areas). The maximum stress induced from the following conditions shall be used:

a. DL of landing area + wt. of helicopter, or

b. DL of landing area + 1.5 of fully loaded helicopter for an impact load distributed over a one square foot area. (This is for a helicopter with rigid or skid type landing gear. For a helicopter with hydraulic landing gear an impact factor of 0.75 is acceptable), or

c. DL + 100 PSF, with an allowable live load reduction (based on the formula in ICBO's UBC, '76 edition Section 2306) of 0.08% per square foot of area supported by the member, not to exceed 40%, or

$R = 23.1\,(1 + {}^{D}/_{L})$, where
R = Reduction in %
D = Dead load acting on area supported by the member
L = Live load acting on area supported by the member

Control Center dead loads and size are not known at this time.

Deck Storage, Staging and Cleaning Area is basically an open area on the existing steel plate deck. The determination for the steel deck dead load is not a part of this contract. The live loads on the deck shall be based on Section 2304 and Table No. 23-A of the ICBO's UBC, '76 edition as given below:

	LL, PSF
Pedestrian Traffic	50
Storage Area - Light	125
Cleaning Area, Incoming Storage Area, Outgoing Storage Area, Staging Area	250

In order to contain toxic fluids for environmental protection of ocean waters a spill area on deck is provided and is bounded by a 6" dike (approximately 75' x 140'). When full it is assumed that there will be no pedestrian traffic or other live loads in the spill area. Using water density of 62.4 PCF the full condition live load would be 32.2 PSF. This is less than the designated 50 PSF, so additional design is not required for the spill area.

Potable Water System component dead loads and sizes are as follows:

COMPONENT	DL, LBS.	SIZE, FT.
RO Purifier Unit (Reverse Osmosis)	2,000	4 x 4 x 8
RO Water Storage Tank	18,000 (Full)	60 x 10 LG
Distribution Pump (P-7)	200	2 x 4 x 2H
Distrubution Pump (P-8)	200	2 x 4 x 2H
Pressure Set	2,500	30 x 6 LG

Sanitary Sewage System component dead loads and sizes are as follows:

COMPONENT	DL, LBS.	SIZE, FT.
Marine Sanitation System	1,650	4-1/2 x 9-1/2 x 3H
Discharge Pump	100	2 x 2 x 2H

Seawater System component dead loads and sizes are as follows:

COMPONENT	DL, LBS.	SIZE, FT.
Potable water system supply pump	100	2 x 3 x 2H
Marine toilets water supply pump	100	2 x 4 x 2H
Marine toilets water supply system pressurizing tank	150	30 x 5 LG
Incinerator quench water supply pump	200	2 x 4 x 2H
Incinerator scrubber water supply pump	250	2 x 4 x 2H
Platform flush and fire fighting water supply pump	200	2 x 4 x 2H
Fire fighting and flush storage tank	10,000 (full)	40 x 10 LG
Hose reel	200	2 x 4 x 2H
Hose reel	200	2 x 4 x 2H

Fuel Storage (4 tanks) and Supply System component dead loads and sizes are as follows:

COMPONENT	DL, LBS.	SIZE, FT.
Fuel Storage Tank	80,000 (full)	90 x 22 LG
Fuel Storage Tank	80,000 (full)	90 x 22 LG
Fuel Storage Tank	80,000 (full)	90 x 22 LG
Fuel Storage Tank	80,000 (full)	90 x 22 LG
Fuel Supply Pump (P-13)	100	2 x 4 x 2H
Fuel Supply Pump (P-14)	100	2 x 4 x 2H
Backpressure Regulator	25	1 x 1 x 1H

Compressed Air System data is insufficient at this time. It has been suggested that an Ingersoll-Rand compressor Model SSR-2000 be used to meet the 150 SCFM @ 90 psi conditions.

Electrical Power System components are known at this time but dead loads and sizes are not. System components are as follows:

(2) 300 KW Diesel Generators
Main Switchboard
Motor Control Center
Transformers
Cables
Interior, Exterior, and Emergency Lighting

APPENDIX B

OFFSHORE PLATFORM CRANE SYSTEMS

TRW

4342.4.79-118
21 August 1979

Mr. David C. Sanchez
Environmental Protection Agency
Industrial Environmental Research Laboratory
Office of Research and Development
Research Triangle Park, North Carolina 27711

Dear Dave:

Enclosed are conceptual sketches and comparative data for three alternative crane systems for handling hazardous waste containers on the offshore incineration platform, Task 29 of Contract 68-02-2613. Each system is capable of unloading containers from ships and moving them about the platform.

Sketch "A" shows a standard boom crane which could be used in conjunction with a forklift truck to move containers to all areas of the platform. In order to reach all areas with a crane only, either a crane of double the capacity shown or a second identical crane mounted on the opposite side of the platform would be required. Most oil drilling platforms utilize two or more cranes.

Sketches "B" and "C" show an interlocking bridge crane and a gantry crane, respectively. Each of these cranes require rail extensions beyond the edge of the platform in order to be able to unload ships. The interlocking bridge crane can transport material to all areas of the platform but requires numerous overhead rails and supports.

Relative costs (ROM) and capabilities of the three proposed systems are listed in the enclosed table. We would appreciate your comments regarding the relative merits of each system before finalizing our baseline design of the offshore incineration facility.

Sincerely yours,

Robert J. Johnson

Robert J. Johnson
Task Manager
Bldg. O-1, Room 2040

RJJ:ams
Enclosures (2)

cc: EPA - B. Ramsey
USCG - LCDR T. Adams
TRW - J. Clarke
- E. Flynn
- A. Samsonov

DEFENSE AND SPACE SYSTEMS GROUP OF TRW INC. • ONE SPACE PARK, REDONDO BEACH, CALIFORNIA 90278 • (213) 535-4321

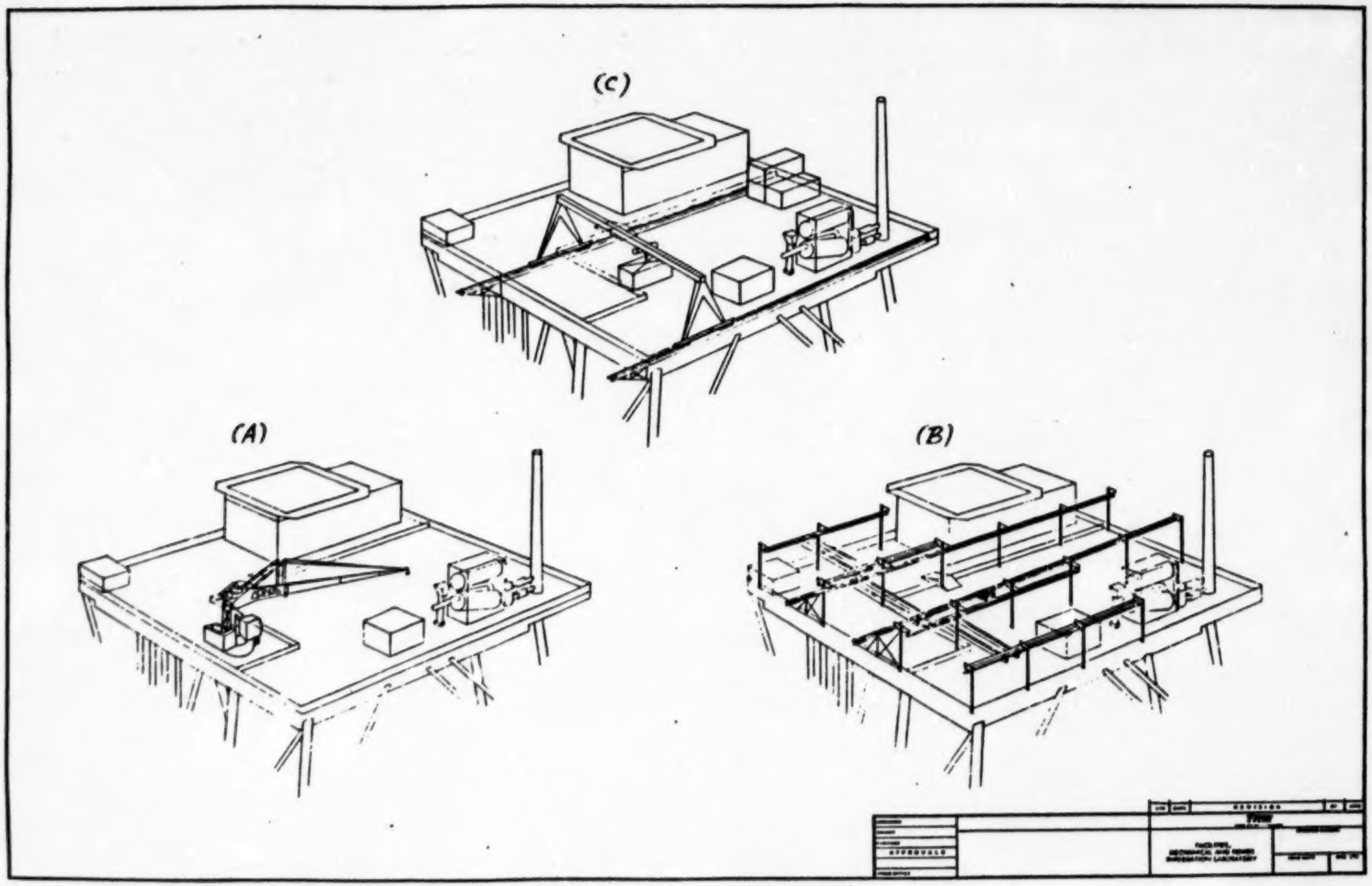
(C)
(A)
(B)
REVISIONS
TRW
APPROVALS

Figure B-1. Alternative Crane Systems (TRW)

TABLE B-1. CRANE SYSTEM COMPARISON

CRANE SYSTEM	DESCRIPTION	COST			WEIGHT	COMPLEXITY		INSTALLATION COST
		ORIGINAL	OPERATING	MAINTENANCE		OPERATING	MAINTENANCE	
A.	TWO 50 TON CAPACITY, 100 FT. BOOM CRANES	HIGHEST ($200 K x 2 = $400 K)	POWER: 480 V FROM PLATFORM OR INDIVIDUAL DIESEL POWER SUPPLY	MORE COMPLEX RIGGING & LUBRICATION	50 TONS EACH, MINIMUM = 100 TONS	MOST COMPLEX HOISTING ARRANGEMENT. CANNOT USE IN HIGH WIND	EXTRA DIESEL ENGINES IF THIS TYPE OF CRANE IS USED, ALSO HYDRAULIC EQUIPMENT	REQUIRES EXTENSIVE FOUNDATION STRUCTURES. ONE CRANE CANNOT ERECT THE OTHER.
B.	THREE 30 FT. BRIDGES, TWO 20 TON HOISTS, INTERLOCKING. 20 FT. HOOK HEIGHT	MEDIUM ($100 K PLUS EXTENSION TO PLATFORM @ $15 K)	POWER: 480 V FROM PLATFORM SUPPLY	ELECTRICAL RUNWAYS OPEN TO WEATHER. RADIO CONTROL FOR HOIST.	70 TONS	6 BUTTON CONTROL THRU RADIO CONTROL DEVICE	NORMAL BRIDGE CRANE & HOIST MAINTENANCE. ELECTRICAL + ELECTRONIC CONTROLS.	REQUIRES COLUMNS AND RUNWAY GIRDERS WHICH PROBABLY NEED ADDITIONAL DECK BRACING.
C.	ONE GANTRY, 60 FT. SPAN, 20 TON HOIST.	LOWEST ($ 70 K PLUS EXTENSION TO PLATFORM @ $15 K)	POWER: 480 V FROM PLATFORM SUPPLY.	RADIO CONTROL. 1/3 LESS RUNWAY FOR ELECTRICAL.	50 TONS	6 BUTTON CONTROL THRU RADIO CONTROL DEVICE.	NORMAL BRIDGE CRANE & HOIST MAINTENANCE. ELECTRICAL & ELECTRONIC CONTROLS.	REQUIRES RAILWAY WHICH PROBABLY NEEDS ADDITIONAL DECK BRACING.

NOTES:

1. ALL WEIGHTS AND COSTS ARE ROM ESTIMATES TO SHOW RELATIVE MERITS OF THE SYSTEMS. MORE DETAILED DESIGN WOULD HAVE TO BE DONE TO REFINE THESE NUMBERS.
2. ALL SYSTEMS WERE BASED ON 20 TON CAPACITY. REDUCING THIS TO 10 TONS WILL REDUCE WEIGHTS AND COSTS PROPORTIONALLY.
3. THE ADDITIONAL STEEL FRAMING FOR SYSTEMS B & C HAS TO BE INCLUDED IN THE COST SINCE THEY CANNOT UNLOAD THE SUPPLY SHIPS WITHOUT THESE EXTENSIONS. (SEE DRAWING)
4. INSTALLATION COSTS AND WEIGHT OF SUPPORTING STEEL DEPEND ON DETAIL DESIGN AND HAVE NOT BEEN ESTIMATED.

The following is a copy of a hand-written communication to LCDR. Adams, G-WEP-1/73 from C. E. Smith, G-ECV-2/61 with regard to the suggested crane systems mentioned in R. Johnson's letter of August 21, 1979.

4 September 1979

LCDR Adams,

1) I have reviewed the attached letter from TRW concerning the conceptual crane systems. The following are my comments:

(a) System "A" using one crane and the forklift option would allow for the most flexible system. I am sure there will be many changes in the operational procedures and this system could easily be adjusted to any changes; Storage and work areas should be as free as possible from fixed equipment. I believe that this system also would be easier to use when offloading from a moored vessel. Some type of fendering system will have to be attached to the platform to keep the moored vessel from damaging the structure. The other two systems may not give the desired flexibility in respect to the moored vessel.

(b) System "C" will require a considerable amount of structural work in order to support a movable structure as well as the desired cantilevered conditions required to reach the moored vessel. Also with this type system certain areas of the deck must be kept open and you do lose some degree of flexibility to charge the operational procedures.

(c) System "B" is even more complex and would require a considerable amount of structural work in the deck.

2) I have attached another sheet which give three other concepts.

(a) System (A) would turn the Gantry crane 90 degrees. This would allow the elimination of the cantilevered elements. The main front of the crane would run under the supporting legs and cantilever over the sides; this is not uncommon.

(b) System (B) would be similar to TRW's A System but would have a larger beam. This would be a fixed structure which could rotate at its base and service the work and storage area. A smaller version could be used with a forklift.

(c) System (C) is a crane like those used in the building industry. These type cranes can have beams up to 125 feet or more. It would be fixed to the deck and could service all areas; it would also give some flexibility to unloading the moored vessel. A lot would depend on the required service loads (maximum $\approx$ 5 tons).

3) Of all the system, I would suggest either TRW's (A) or my (C) system. The cost would be about the same and there would be less structural change to the deck. I believe that TRW's cost for the cantilevered elements are low; deck change could amount to almost the cost of the crane, $50,000±. Attached are two items, one showing a crane on a platform, the other for a ramp.

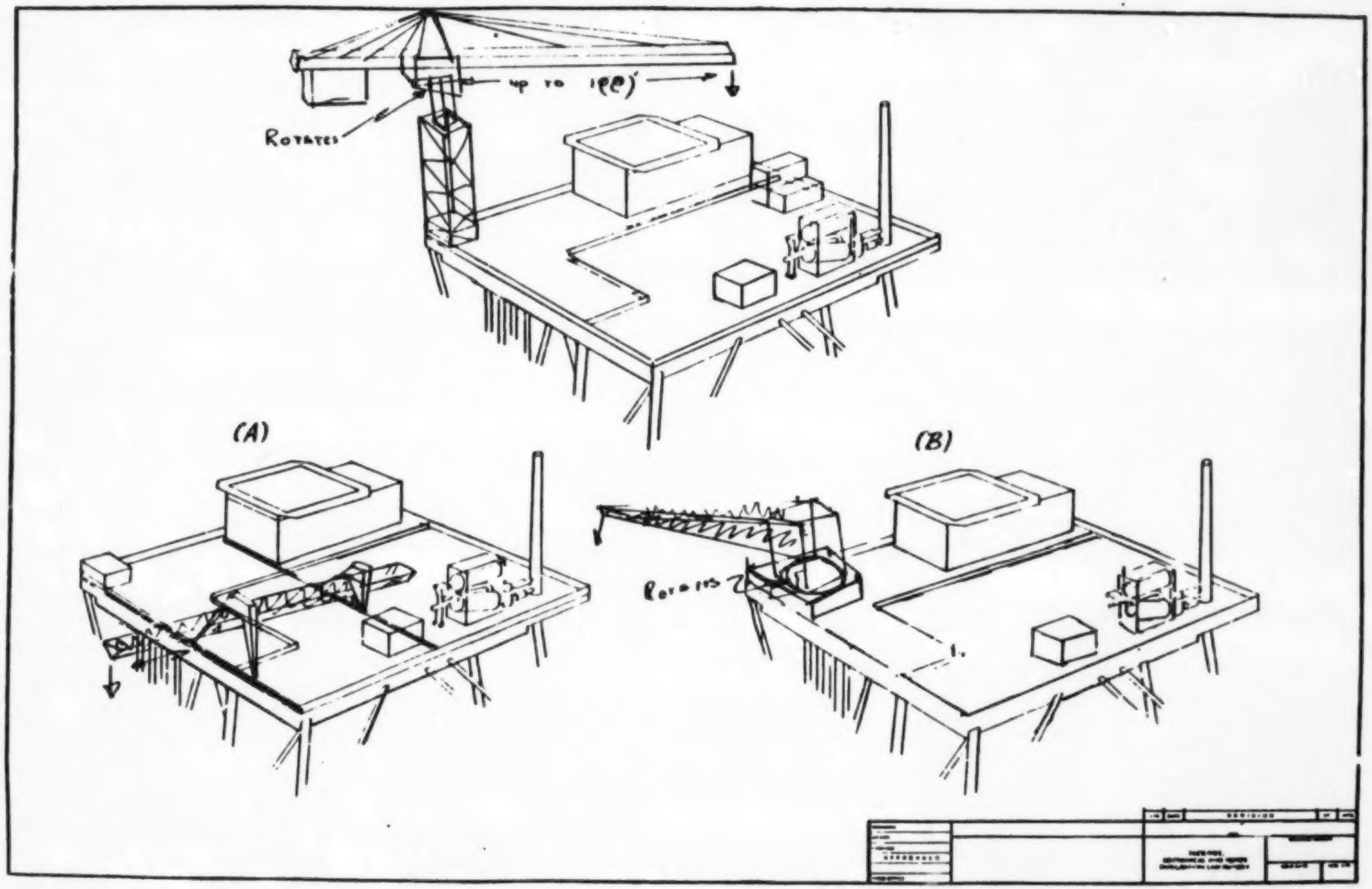
Rotates
up to 100'
(A)
(B)
Rotates

Figure B-2. Additional Crane Concepts (USCG)

APPENDIX C

COST DATA

TRW
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ENVIRONMENTAL, POWER AND FACILITIES DEPARTMENT

CONSTRUCTION COST ESTIMATE

CONSTRUCTION PERIOD ______ QTR ______
PROJECT EPA INCINERATOR NUMBER ______
PACKAGE CONTAINERS SHEET ____ OF ____
ESTIMATOR E. FLYNN DATE 10-19-79

REF.	ITEM	QUANTITY	UNITS	UNIT COST	TOTAL COST
	ISO container - 8x8x20, NEW	14	$	8,158	$114,200
	quot by Fruehauf - (Quotes as low as $3900				
	are possible from overseas suppliers).				
	ISO container - special design, liquid, 2500 gal.	77		16,000	$1,282,000
	avg. estimate: $16,000 each.				
	BMC, dry, similar to TOTE #S-90	60		789	$47,000
	per quote from Tote Corp.				
	BMC, liquid, similar to TOTE #S-549	350		656	$229,600
	per quote from TOTE Corp.				
	TILT UNLOADER - QUOTE FROM TOTE Corp.	1	carbon stl.		4,800
		(1	stainless stl.)		5,840
	FLEXIBLE VAN TANK 2100 gal.	1			3500
	per quote from Goodyear.				
	55 gal. drum, tight head, "DOT. 17C" in quantities	1		22.50	22.50
	of 1000. used drums	1		13.–	13.–
	(Numerous quotes)				

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CONSTRUCTION COST ESTIMATE

CONSTRUCTION PERIOD ______ QTR ______
PROJECT EPA - INCINERATOR NUMBER ______
PACKAGE MECH & ELEC. LABOR EXTENSION SHEET ____ OF ____
ESTIMATOR E. FLYNN DATE 10-19-79

REF.	ITEM SUBSYSTEM	QUANTITY	UNITS	UNIT COST	TOTAL COST
	POTABLE WATER @ PAR 40% O&A −12% LOCATION.	368	M.H.	18.48	$6800
	SAN. SEWAGE " "	98			1800
	DECONTAMINATION " "	144			2600
	SEAWATER " "	296			5500 ~~4700~~
	FUEL STORAGE " "	248			4600
	PLATFORM SAFETY EQUIP " "	594		19.36	11 500
	AIR COMPRESSOR " "	96			1860
	E.C.S. EQUIP.	84			1530
	ELECTRICAL EQUIP. " −14% LOCATION	1150		17.88	20570
	TOTAL				$ 56,760
	FOR WORK ON OCEAN PLAT. (X2), USE —				$ 113,600
	Add material cost				522,900
	Total labor & material cost for sub-systems.				$ 636,500

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ENVIRONMENTAL, POWER AND FACILITIES DEPARTMENT

CONSTRUCTION COST ESTIMATE

CONSTRUCTION PERIOD 1979 MEANS QTR

PROJECT EPA OFFSHORE INCINERATOR NUMBER

PACKAGE SHORE BASE SUBSYSTEMS SHEET 1 OF 4

ESTIMATOR R COREY DATE OCT 19 1979

REF.	ITEM	QUANTITY	UNITS	UNIT COST	TOTAL COST
	SUBSYSTEM SUMMARY SHEET				
3	WASTE SUBSYSTEM				879.00
4	POTABLE WATER SUBSYSTEM				2546.00
5	TOXIC WASTE SUBSYSTEM				2725.00
6	SAFETY SYSTEMS				2620.00
7	DELETED				
8	FUEL GAS SUBSYSTEM				440.00
9	COMMUNICATIONS SUBSYSTEM				500.00
					9710.00

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CONSTRUCTION COST ESTIMATE

CONSTRUCTION PERIOD 1979 MEANS QTR
PROJECT EPA OFFSHORE INCINERATOR NUMBER
PACKAGE SHORE BASE SUBSYSTEMS SHEET 2 OF 4
ESTIMATOR R COREY DATE OCT 17 1979

REF.	ITEM	QUANTITY	UNITS	UNIT COST	TOTAL COST
	EXCAVATING TRENCH - SEWER LINE	54	CY	.71	38.00
	" " LABOR	54	CY	1.27	68.00
	VITRIFIED CLAY SEWER PIPE	240	LF	1.10	264.00
	LABOR	240	LF	1.22	293.00
	HAND EXCAVATE FOR BELLS LAB	240	LF	.54	130.00
	BACKFILL EQUIP	54	CY	.33	18.00
	LAB	54	CY	.15	8.00
	TAMPING EQUIP	54	CY	.28	15.00
	LABOR	54	CY	.83	45.00
					335 MAT
					544 LAB
					879 TOT
	EXCAVATING TRENCH - WATER & FIRE SUPPLY	131	CY	.71	93.00
	LABOR	131	CY	1.27	166.00
	POLYVINAL CHLORIDE 1½	150	LF	.26	39.00
		150	LF	1.05	158.00
	ASBESTOS CEMENT 4" FIRE LINE	490	LF	2.25	1103.00
		490	LF	1.05	514.00
	HAND EXCAVATE FOR BELLS	490	LF	.54	264.00
	BACKFILL EQUIP.	131	CY	.33	43.00
	LAB	131	CY	.15	20.00
	TAMPING EQUIP.	131	CY	.28	37.00
	LABOR	131	CY	.83	109.00
					1315.00 MAT
					1231.00 LAB
					2546.00 TOT

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ONE SPACE PARK · REDONDO BEACH, CALIFORNIA
ENVIRONMENTAL, POWER AND FACILITIES DEPARTMENT

CONSTRUCTION COST ESTIMATE

CONSTRUCTION PERIOD 1979 MEANS QTR
PROJECT EPA OFFSHORE INCINERATOR NUMBER
PACKAGE SHOREBASE SUBSYSTEMS SHEET 3 OF 4
ESTIMATOR DATE OCT 17 1979

REF.	ITEM	QUANTITY	UNITS	UNIT COST	TOTAL COST
	EXCAVATING TRENCH - FUEL GAS	36	CY	.71	26.00
	LABOR	36	CY	1.27	46.00
	POLYETHYLENE 60 PSI, 1¼ DIA MAT.	160	LF	.81	130.00
	LABOR	160	LF	1.12	180.00
	BACKFILL EQUIP.	36	CY	.33	12.00
	LABOR	36	CY	.15	6.00
	TAMPING EQUIP.	36	CY	.28	10.00
	LABOR	36	CY	.83	30.00
					178.00 MAT
					262.00 LABOR
					440 TOT
	TOXIC SUMP SYSTEM				
	1/2 HP SUMP PUMP MAT.	1	1	805	805
	LABOR	1	1	85	85
	3000 GAL STEEL UNDERGROUND MAT.	1	1	1200	1200
	LABOR	1	1	265	265
	EXCAVATION FOR TANK MAT.	72	CY	.71	51.00
	LABOR	72	CY	1.27	91.00
	BACK FILL EQUIP.	45	CY	.33	15.00
	LABOR	45	CY	.15	7.00
	EXCAVATING TRENCH DRAIN MAT.	11	CY.	.71	8.00
	LABOR	11	CY	1.27	14.00
	ASBESTOS CEMENT 4" MAT.	50	LF	2.25	113.00
	LABOR	50	LF	1.05	53.00
	BACKFILL EQUIP.	11	CY	.33	4.00
	LABOR	11	CY	.15	2.00
	TAMPING EQUIP.	11	CY	.28	3.08
	LABOR	11	CY	.83	9.00

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ENVIRONMENTAL, POWER AND FACILITIES DEPARTMENT

CONSTRUCTION COST ESTIMATE

CONSTRUCTION PERIOD 1979 MEANS QTR
PROJECT EPA OFFSHORE INCINERATOR NUMBER
PACKAGE SHOREBASE SUBSYSTEMS SHEET 4 OF 4
ESTIMATOR DATE OCT 17 1979

REF.	ITEM	QUANTITY	UNITS	UNIT COST	TOTAL COST
	SUB TOTALS FOR TOXIC WASTE SUBSYSTEM	MAT			2200
		LABOR			525
					2725
	COMMUNICATIONS SUBSYSTEM	1	LS	500	500
	SAFETY SUBSYSTEMS				
	2-EMERGENCY SHOWERS MAT.	2	2	175	350
	LABOR	2	2	53	106
	2-EYE WASH FOUNTAINS MAT.	2	2	170	340
	LABOR	2	2	53	106
	3-HOSE RACK CAB MAT.	3	3	85	255
	LABOR	3	3	36	108
	3-HOSE RACK MAT.	3	3	12	36
	LABOR	3	3	11	33
	300 LF HOSE 1½ DIA MAT.	300	LF	.85	255
	NOZZLES MAT.	3	EA	100	300
	2-EMERG SHOWER-EYE WASH COMBO MAT.	2	EA	310	620
	INST	2	EA	53	106
					2160 MAT
					400 LABOR
					2620

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ENVIRONMENTAL, POWER AND FACILITIES DEPARTMENT

CONSTRUCTION COST ESTIMATE

CONSTRUCTION PERIOD 1979 MEANS QTR
PROJECT EPA OFF SHORE INCINERATION NUMBER
PACKAGE SHEET 1 OF 2
ESTIMATOR R COREY DATE OCT 8 1979

REF.	ITEM	QUANTITY	UNITS	UNIT COST	TOTAL COST
	SURVEY	1600	LF	.50	800.00
	CLEAR & GRUB EQUIP	4	ACRE	535	2140.00
	LABOR	4	AC	755	3120.00
	BORINGS		LS	250	250.00
	FENCE 6' W 3 STRANDS BARBED MAT	1540	LF	4.75	7,315.00
	LABOR	1540	LF	2.03	3,126.00
	GATE OVERHEAD SLIDE 18' LONG MAT	3x18	LF	85	4,590.00
	LABOR	3x18	LF	11.55	623.00
	PAVING				
	PREP BASE LARGE AREA LABOR	4445	SY	.37	1,644
	BASE COURSE 6" MAT	4445	SY	1.15	5,111
	LABOR	4445	SY	.25	1,111
	WEARING COURSE 1½" TH	4445	SY	1.20	5,334
		4445	SY	.40	1,779
	DIKED AREA				
	COMMON BARROW MAT	446	CY	.80	356
	LABOR	446	CY	1.65	735
	FINE GRADING MAT	933	SY	.21	196
	LABOR	933	SY	.13	121
	COMPACTING EQUIP	446	CY	.56	249
	LAB	446	CY	.41	182
	BASE COARSE MAT	3333	SY	.56	1866
	LAB	3333	SY	.18	600
	CONCRETE PAVING 4" MAT	3333	SY	6.65	22,164
	LAB	3333	SY	1.00	3,333
	RAIL SIDING MAT	210	LF	27	5,670
	LAB	210	LF	11	2,310
	BUILDING FOUNDATION MAT	107	CY	53	5,671
	LAB	107	CY	31	3,317

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ONE SPACE PARK · REDONDO BEACH, CALIFORNIA
ENVIRONMENTAL, POWER AND FACILITIES DEPARTMENT

CONSTRUCTION COST ESTIMATE

CONSTRUCTION PERIOD 1979 MEANS QTR
PROJECT EPA OFFSHORE INCINERATION NUMBER
PACKAGE SHEET 2 OF 2
ESTIMATOR R CODER DATE OCT 8 1979

REF.	ITEM	QUANTITY	UNITS	UNIT COST	TOTAL COST
	BUILDING BARROW MAT	611	CY	.80	488
	LAB	611	CY	1.65	1008
	COMPACT EQUIP	611	CY	.56	342
	LAB	611	CY	.41	250
	SLAB 12" TK M.AT	5600	SF	1.23	6880
	LAB	5600	SF	.61	3416
	STEEL MAT	20.5	TON	395	8,097
	LABOR	20.5	TON	215	4,407
	BUILDING FRAME MAT & LABOR	5000	SF	17.50	87,500
	INTERIOR MAT	2000	SF	4.00	8,050
	LABOR	2000	SF	2.00	4,000
					208,000

208,161

ESTIMATE SUMMARY APPENDIX III

PROJECT: EPA - OFFSHORE INCINERATOR

MECHANICAL & ELECTRICAL SUPPORT SYSTEMS

EQUIPMENT COST ESTIMATE SUMMARY

ESTIMATE NO.

SHEET NO. III - 1

PREPARED BY: DATE: 9/10/79

CHECKED BY: DATE:

MAIN ACCOUNT	DESCRIPTION	QUANTITY	MATERIALS		LABOR				SUB-CONTRACT		TOTAL
			UNIT PRICE	AMOUNT	UNIT M H	TOTAL M H	RATE	AMOUNT	UNIT PRICE	AMOUNT	
	POTABLE WATER SYST					368					$ 70,000
	SANITARY SEWAGE "					98					14,700
		DELETED									
	DECONTAMINATION "					144					8,500
	SEAWATER SYSTEMS					296					28,000
	FUEL STORAGE & SUPPY SYST					248					43,000
	PLATFORM SAFETY EQUIPMENT					594					193,000
	AIR COMPRESSOR					96					14,000
	ENVIRONMENTAL CONTROL EQUIPMENT					84					15,400
	ELECTRICAL EQUIPMENT					1150					136,300
	EQUIPMENT TOTAL →										522,900
	LABOR (MHRS)					3078					

NOTES

1. ESTIMATES DO NOT INCLUDE ANY SHIPPING OR PROCUREMENT COSTS.
2. LABOR HOURS ESTIMATE ARE FOR LAND BASED INSTALLATION - MOBILE ALA.

ESTIMATE DETAILS

PROJECT: EPA - OFFSHORE INCINERATOR

ACCOUNT: POTABLE WATER SYSTEM

ESTIMATE NO.

SHEET NO. III - 2

PREPARED BY: DATE:

CHECKED BY: DATE:

DESCRIPTION	QUANTITY	MATERIALS		LABOR				SUB-CONTRACT		TOTAL
		UNIT PRICE	AMOUNT	UNIT M.H.	TOTAL M.H.	RATE	AMOUNT	UNIT PRICE	AMOUNT	
1. SEAWATER PUMP	1	SEE SEA WATER SYSTEMS								
2. R.O. WATER PURIFICATION UNIT	1				120				50K	50K
3. R.O. WATER STORAGE TANK	1				32				2K	2K
4. DISTRIBUTION PUMPS	2			16	32			1.5	3K	3K
5 PRESSURE CONTROL UNIT	1				16				10K	10K
6. PIPING, VALUES & MISC MAT'LS	LOT				168				5K	5K
TOTAL EQUIP.										70K
LABOR					368					

ESTIMATE DETAILS

PROJECT: EPA OFFSHORE INCINERATOR
ACCOUNT: SANITARY SEWAGE SYSTEM

ESTIMATE NO.
SHEET NO. III-3
PREPARED BY: DATE:
CHECKED BY: DATE:

DESCRIPTION	QUANTITY	MATERIALS		LABOR				SUB-CONTRACT		TOTAL
		UNIT PRICE	AMOUNT	UNIT M.H.	TOTAL M.H.	RATE	AMOUNT	UNIT PRICE	AMOUNT	
1. MARINE SANITATION SYSTEM	1				32			12,000		12,000
2. DISCHARGE PUMP UNIT	1				16			1200		1,200
3. PIPING & MISC MAT'LS	LOT				50			1,500		1,500
TOTAL EQUIP										14,700
LABOR					98					

ESTIMATE DETAILS

PROJECT: EPA - OFFSHORE INCINERATOR
ACCOUNT:
DECONTAMINATION SYSTEM

ESTIMATE NO.
SHEET NO. III-5
PREPARED BY: DATE:
CHECKED BY: DATE:

DESCRIPTION	QUANTITY	MATERIALS		LABOR				SUB-CONTRACT		TOTAL
		UNIT PRICE	AMOUNT	UNIT M.H.	TOTAL M.H.	RATE	AMOUNT	UNIT PRICE	AMOUNT	
1. WASH AREA COLLECTION TANK, 3,000 GAL	1				48			6,000		6,000
3. WASTE PUMP (P-11)	1.				16			500		500
4. PIPING, VALVES & MISC MAT'L	LOT				80					2,000.
TOTAL EQUIP COST										8,500
LABOR (MHRS)					144					

ESTIMATE DETAILS

PROJECT: EPA - OFFSHORE INCINERATOR
ACCOUNT:
SEAWATER SYSTEMS

ESTIMATE NO.
SHEET NO. III - 6
PREPARED BY: DATE: 9/6/79
CHECKED BY: DATE:

DESCRIPTION	QUANTITY	MATERIALS		LABOR				SUB-CONTRACT		TOTAL
		UNIT PRICE	AMOUNT	UNIT M.H.	TOTAL M.H.	RATE	AMOUNT	UNIT PRICE	AMOUNT	
1. POTABLE WATER SYSTEM SUPPLY PUMP (P-1)	1				32					2,000
~~2. MARINE TOILETS WATER SUPPLY PUMP (P-2)~~	~~1~~									~~3,000~~
3. MARINE TOILETS WATER SUPPLY SYSTEM PRESSURIZING TANK	1				16					2,000
4. INCINERATOR QUENCH WATER SUPPLY PUMP (P-3)	1				32					5,000
5. INCINERATOR SCRUBBER WATER SUPPLY PUMP	1				32					6,000
6. PLATFORM FLUSH AND FIRE FIGHTING WATER SUPPLY PUMP (P-5)	1				32					5,000
7. FIRE FIGHTING AND DECK FLUSH STORAGE TANK	1				32					4,000
8. PIPING, VALVES & MISC MAT'L	LOT				120					4,000
TOTAL EQUIP										28,000
LABOR (MHRS)					296					

ESTIMATE DETAILS

PROJECT: EPA · OFFSHORE INCINERATOR

ACCOUNT:

FUEL STORAGE & SUPPLY SYSTEM

ESTIMATE NO.

SHEET NO. III-7

PREPARED BY: DATE: 9/6/79

CHECKED BY: DATE:

DESCRIPTION	QUANTITY	MATERIALS		LABOR				SUB-CONTRACT		TOTAL
		UNIT PRICE	AMOUNT	UNIT M.H.	TOTAL M.H.	RATE	AMOUNT	UNIT PRICE	AMOUNT	
1. FUEL STORAGE TANK	4			32	128			10,000	40,000	40,000
2. FUEL SUPPLY PUMP	2			16	32			250	500	500
3. BACK PRESSURE REGULATOR	1			8	8			500	500	500
4. PIPING, VALVES & MISC MAT'LS	LOT			80	80			2000		2000
TOTAL EQUIP										43,000
LABOR (MHRS)					248					

ESTIMATE DETAILS

PROJECT: EPA OFFSHORE INCINERATOR
ACCOUNT: PLATFORM SAFETY EQUIPMENT

ESTIMATE NO.
SHEET NO. III -8
PREPARED BY: DATE:
CHECKED BY: DATE:

DESCRIPTION	QUANTITY	MATERIALS		LABOR				SUB-CONTRACT		TOTAL
		UNIT PRICE	AMOUNT	UNIT M.H.	TOTAL M.H.	RATE	AMOUNT	UNIT PRICE	AMOUNT	
1. PORTABLE FIRE EXTINGUISHERS	17			2	34			.80		1,400
2. FOAM SYSTEMS	3			32	96			2,500		7,500
3. LIFE FLOATS (ESCAPE CAPSULES)	2			192	384			90,000		180,000
4. LIFE PRESERVERS	20				–			25		500
5. RING LIFE BUOY	8			2	16			125		1,000
6. EMERGENCY RADIO	1				–			500		500
7. HOSE REELS	2			16	32			400		800
8. LITTER								200		200
9. FIRST AID KIT								100		100
10. SAFETY SHOWERS & EYE WASH	2			16	32			500		1000
TOTAL EQUIP.										193,000
LABOR					594					

ESTIMATE DETAILS

PROJECT: EPA OFFSHORE INCINERATOR
ACCOUNT: AIR COMPRESSOR

ESTIMATE NO.
SHEET NO. III - 9
PREPARED BY: DATE: 9/6/79
CHECKED BY: DATE:

DESCRIPTION	QUANTITY	MATERIALS		LABOR				SUB-CONTRACT		TOTAL
		UNIT PRICE	AMOUNT	UNIT M.H.	TOTAL M.H.	RATE	AMOUNT	UNIT PRICE	AMOUNT	
1. 75 CFM, 90 PSI PACKAGED AIR COMPRESSOR, WITH SEPARATE 34 Ft^3 RECEIVER	1				48			13,000		13,000
2. PIPING & MISC MAT'LS	LOT				48			1,000		1,000
TOTAL EQUIP										14,000
LABOR					96					

ESTIMATE SUMMARY

PROJECT: OFF-SHORE EPA INCINERATOR ENVIRONMENTAL CONTROL EQUIPMENT

ESTIMATE NO.

SHEET NO. III-10

PREPARED BY: W. S. PIPER DATE: 9/4/79

CHECKED BY: DATE:

MAIN ACCOUNT	DESCRIPTION	QUANTITY	MATERIALS		LABOR				SUB-CONTRACT		TOTAL
			UNIT PRICE	AMOUNT	UNIT M H	TOTAL M H	RATE	AMOUNT	UNIT PRICE	AMOUNT	
	PERSONNEL BUILDING (PB) AIR CONDITIONER	1		4,200		30					4,200
	PB SUPPLY DUCTWORK, INSULATED (INSTALLED)									5,000	5,000
	PB RETURN DUCTWORK (INSTALLED)									3,000	3,000
	RANGE HOOD & FAN			200		8					200
	DECON ROOM EXHAUST FANS	2	200	400	8	16					400
	CONTROL CENTER (CC) AIR CONDITIONER	1		2,300		30					2300
	CC DUCTWORK (INSTALLED)									300	300
	~~PACKING & LAND TRANSPORTATION~~										~~[illegible]~~
	TOTAL										15,400
	LABOR					84					

ESTIMATE SUMMARY

PROJECT: EPA - Incinerator

ESTIMATE NO.

SHEET NO. III - 18

PREPARED BY: D.C. DATE: 9/

CHECKED BY: DATE:

MAIN ACCOUNT	DESCRIPTION	QUANTITY	MATERIALS		LABOR				SUB-CONTRACT		TO
			UNIT PRICE	AMOUNT	UNIT M.H.	TOTAL M.H.	RATE	AMOUNT	UNIT PRICE	AMOUNT	
	GENERATORS 300KW, 480V, 3Φ, 60HZ	2	40,000	80,000.	90	180					
	SWITCHBOARD 1200A BUS, 480/277V 3Φ, 4W			16,800		70					
	Motor Control Centers			23,000		70					
	Transformers			1500		36.0					
	lighting			9400		350.0					
	wire and cables			5200		380.					
	Panelboards			700		45					
	Miscellaneous			500		10					
				$ 136,300		1141	MH				
							⇒1150 MH				

ESTIMATE DETAILS

PROJECT: EPA - OFFSHORE INCINERATOR
ACCOUNT:
SWITCHBOARD

ESTIMATE NO.
SHEET NO. III - 19
PREPARED BY: DATE:
CHECKED BY: DATE:

DESCRIPTION	QUANTITY	MATERIALS		LABOR				SUB-CONTRACT		TOTA
		UNIT PRICE	AMOUNT	UNIT M.H.	TOTAL M.H.	RATE	AMOUNT	UNIT PRICE	AMOUNT	
SERVICE SECTION 3Φ,4W 480/277V	1	6572	6572	10						
1000A [illegible] BUS										
Ⓦ B46SC12G										
Metering Section	1	3008	3008	10						
VM, AM, SW										
Ⓦ 840A908G02										
Bottom-Feed Pullbox 24" wide	1	374	374	5			+ 15MH	for		
Ⓦ UP24159000							connecting	together		
Distribution section (w/o brkrs)	1	1826	1826	1.0						
480/277V 42"W										
1000A BUS										
Ⓦ N46CD12AW										
					50					
Breakers molded case										
Generator supply - 500A	2	530	1060	5.2	10.4					
Feeders - MCC-1 500A	1	530	530	5.2	5-2					
-2 60A	1	80	80	0.8	0.8					
30A	1	80	80	0.5	0.5					
20A	1	80	80	0.5	0.5					
40A	1	80	80	0.8	0.8					
S.TOT			13,690		68-2					
+~15%			2,110		⃝70					
			15,800	⟹	16,000					

ESTIMATE DETAILS

PROJECT:
ACCOUNT:
MOTOR CONTROL CENTERS   Mean: costs - 1979

ESTIMATE NO.
SHEET NO. III - 20
PREPARED BY: DATE:
CHECKED BY: DATE:

DESCRIPTION	QUANTITY	MATERIALS		LABOR				SUB-CONTRACT		TOTAL
		UNIT PRICE	AMOUNT	UNIT M.H.	TOTAL M.H.	RATE	AMOUNT	UNIT PRICE	AMOUNT	
up to 10 hp	17	425	7225	2.0	34.0					
>10-25 hp	1	525	525	2.1	2.1					
>25-50 hp	4	740	2960	2.6	10.4					
50 - 100 hp	1	1550	1550	3.0	3.0					
100 - 200 hp	1	3200	3200	4.0	4.0					
					53.5					
			22,685	⇒	23,000					
Bolt to floor					5.0					
setting sections					10.0					
					68.5	⇒	70			

ESTIMATE DETAILS

PROJECT: EPA - OFFSHORE INCINERATOR
ACCOUNT: TRANSFORMERS

ESTIMATE NO.
SHEET NO. TR - 21
PREPARED BY: DATE:
CHECKED BY: DATE:

DESCRIPTION	QUANTITY	MATERIALS		LABOR				SUB-CONTRACT		TOTAL
		UNIT PRICE	AMOUNT	UNIT M.H.	TOTAL M.H.	RATE	AMOUNT	UNIT PRICE	AMOUNT	
480-120/208 1φ 30 KVA Dry-type	1	635	635	16	16					
480-120/208 45 KVA Dry-type	1	865	865	20	20					
			$1500		36					

ESTIMATE DETAILS

PROJECT:
ACCOUNT: LIGHTING

ESTIMATE NO.
SHEET NO. III - 22
PREPARED BY: DATE:
CHECKED BY: DATE:

DESCRIPTION	QUANTITY	MATERIALS		LABOR				SUB-CONTRACT		TOTAL
		UNIT PRICE	AMOUNT	UNIT M.H.	TOTAL M.H.	RATE	AMOUNT	UNIT PRICE	AMOUNT	
Fluorescents " 2 40W	100	50	5000	1.5	150					
emerg lights, battery operated	10	260	2600	2.0	20					
exterior (incandescents)	36	50	1800	5	180					
			9400		350					

ESTIMATE DETAILS

PROJECT:
ACCOUNT: WIRE AND CABLE (USE AVG 150 FT RUNS)

ESTIMATE NO.
SHEET NO. III - 23
PREPARED BY: DATE:
CHECKED BY: DATE:

DESCRIPTION	QUANTITY	MATERIALS		LABOR				SUB-CONTRACT		TOT
		UNIT PRICE	AMOUNT	UNIT M.H.	TOTAL M.H.	RATE	AMOUNT	UNIT PRICE	AMOUNT	
#12, 3-wire, 600v armored	2250 F	0.33	750.	0.04	90					
#10 " "	750 F	0.52	400.	0.06	45					
#8	450 F	0.79	320.	0.08	36					
#4	300 F	2.00	600.	0.12	36					
250MCM	150 F	9.20	1380.	0.32	48					
S.TOTAL			3450		255					
9 Feeders plus miscell. branch ckts - use 50% of S.TOT			1725		125					
			5175		380					520

ESTIMATE DETAILS

PROJECT:
ACCOUNT:
PANELBOARDS

ESTIMATE NO.
SHEET NO. III - 24
PREPARED BY: DATE:
CHECKED BY: DATE:

DESCRIPTION	QUANTITY	MATERIALS		LABOR				SUB-CONTRACT		TOTAL
		UNIT PRICE	AMOUNT	UNIT M.H.	TOTAL M.H.	RATE	AMOUNT	UNIT PRICE	AMOUNT	
120/208 V 3Ø, 4W, 30 CKT 100A BUS	1	310	310	20	20					
120/208 V, 3Ø, 4W 40CKT 225A BUS	1	390	390	25	25					
			700		45					

ESTIMATE DETAILS

PROJECT: EPA SHORE BASE SUPPORT FACILITY
ACCOUNT:

ESTIMATE NO.
SHEET NO. 1 of 1
PREPARED BY: H B DATE:
CHECKED BY: DATE:

DESCRIPTION	QUANTITY	MATERIALS		LABOR				SUB-CONTRACT		TOTAL
		UNIT PRICE	AMOUNT	UNIT M.H.	TOTAL M.H.	RATE	AMOUNT	UNIT PRICE	AMOUNT	
A/C UNIT	1		3500		16				3500	35
DIFFUSERS (CEILING)	8	40	320		16					
DOOR GRILLES	5	17	85		8					
DUCT WORK	LOT		350		16					
DUCT INSULATION	LOT		100		10					
ELECTRICAL	LOT		100		8					
BALANCING	LOT		—		16					
TOTAL, EQUIP & MAT'L			4455							
LABOR (MHRS)					90 MHRS					

ESTIMATE SUMMARY

PROJECT: EPA Shore Base Support Facility

ESTIMATE NO. – CONCEPTUAL
SHEET NO.
PREPARED BY: M. Hunter /DC DATE: 10/79
CHECKED BY: DATE:

MAIN ACCOUNT	DESCRIPTION	QUANTITY	MATERIALS		LABOR				SUB-CONTRACT		TOTAL
			UNIT PRICE	AMOUNT	UNIT M.H.	TOTAL M.H.	RATE	AMOUNT	UNIT PRICE	AMOUNT	
	Panelboards	2		1700		45					
	Transfomer	1		635		16					
	Motor starters			735		18					
	Lighting /receptacles	–		18,410		692					
	grounding	–		2,160		98					
				23,640		869					

ESTIMATE DETAILS

PROJECT: EPA Shore Base Support Facility

ACCOUNT:

motor starters (ckt brkr type)

ESTIMATE NO. - CONCEPTUAL -

SHEET NO.

PREPARED BY: M. Hunter / DC DATE: 10/79

CHECKED BY: DATE:

DESCRIPTION	QUANTITY	MATERIALS		LABOR				SUB-CONTRACT		TOTAL
		UNIT PRICE	AMOUNT	UNIT M.H.	TOTAL M.H.	RATE	AMOUNT	UNIT PRICE	AMOUNT	
starters 3φ 0-10hp	3	245	735	6	18					

ESTIMATE DETAILS

PROJECT: EPA Shore Base Support Facility

ACCOUNT: Panelboards / transformers

ESTIMATE NO. – CONCEPTUAL –

SHEET NO.

PREPARED BY: M. Hunter / DC DATE: 10/79

CHECKED BY: DATE:

DESCRIPTION	QUANTITY	MATERIALS		LABOR				SUB-CONTRACT		TOTAL
		UNIT PRICE	AMOUNT	UNIT M.H.	TOTAL M.H.	RATE	AMOUNT	UNIT PRICE	AMOUNT	
Panelboard – 3Φ 277/480V 225A Bus, 42 CKT circuit breaker type w/main	1	1400	1400	30	30					
Panelboard – 120/208 V 100A Bus, 24 CKT circuit breaker type w/ lugs only	1	300	300	15	15					
S.TOT			1700		45					
30KVA XFMR 480–120/208V, dry-type	1	635	635	16	16					
Sheet tot			2335		61 MH					

ESTIMATE DETAILS

PROJECT: EPA - Shore Base Support Facility
ACCOUNT:
Lighting / receptacles

ESTIMATE NO. -CONCEPTUAL -
SHEET NO.
PREPARED BY: M. Hunter / DC DATE: 10/7
CHECKED BY: DATE:

DESCRIPTION	QUANTITY	MATERIALS		LABOR				SUB-CONTRACT		TOTAL
		UNIT PRICE	AMOUNT	UNIT M.H.	TOTAL M.H.	RATE	AMOUNT	UNIT PRICE	AMOUNT	
INTERIOR										
Fluorescentals 1'x4'	72	50	3600	1.5	108					
2-40W w/ R.S., CW										
Emerg. Lights - Battery operated	10	260	2600	2.0	20					
EXTERIOR										
Hg-Vapor 100W	42	125	5250	2.0	84					
Poles 10ft wood	25	100	2500	5.0	125					
WIRE/CONDUIT										
Lighting - 100ft/CKT, 2#12	24CKTS	100	2400	6.2	150					
Receptacles - 100ft/CKT, 2#12	15CKTS	100	1500	6.2	93					
RECEPTACLES	82	5	410	1.0	82					
SWITCHES	30	5	150	1.0	30					
			$18,410		692 MH					

ESTIMATE DETAILS

PROJECT: EPA Shore Base Support Facility

ACCOUNT: Grounding

ESTIMATE NO. - CONCEPTUAL -

SHEET NO.

PREPARED BY: M. Hunter / DC DATE: 10/79

CHECKED BY: DATE:

DESCRIPTION	QUANTITY	MATERIALS		LABOR				SUB-CONTRACT		TOTAL
		UNIT PRICE	AMOUNT	UNIT M.H.	TOTAL M.H.	RATE	AMOUNT	UNIT PRICE	AMOUNT	
Ground rods 3/4" ϕ x 10'	40	25	1000	1.2	48					
Cu-clad steel										
Bare Cu wire										
#4/0 - Bldg perim -	400 LF	0.85	340	0.03	12					
#8 - Fence perim -	1600 LF	0.20	320	0.008	13					
Connectors, brazing, etc	LOT		500		25					
			2160		98					